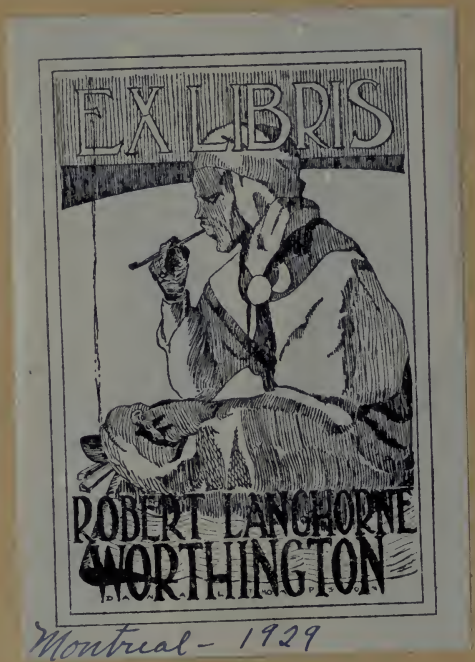
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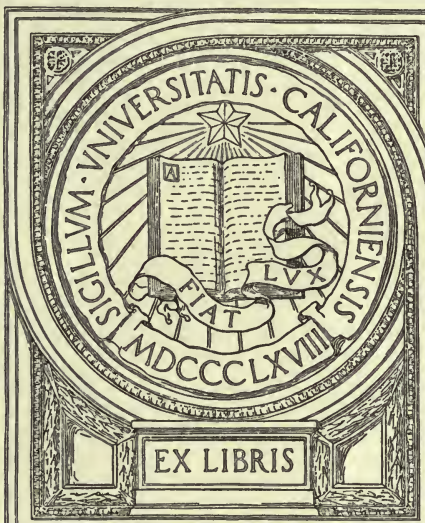

A Guide to

Regional Anatomy

by

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FOREWORD

This book has been written at the urgent request of the students of my anatomy classes at Dalhousie University, to whom it is hereby dedicated. The idea involved in the production of this book is to provide the student with a brief though concise guide to his work in the dissecting room, which is the only place where an adequate knowledge of Anatomy can be acquired. It was manifestly impossible to provide illustrations in a work sold for so small an amount; but even apart from that fact the methods of teaching adopted by the author require that the student should make his own diagrams and sketches. Visualising is Nature's stimulus to the memory centres, and is the *open sesame* to a true and permanent knowledge of Anatomy.

JOHN CAMERON.

October, 1919.

PREFACE TO THE SECOND EDITION.

In this edition the book has been re-written and re-modelled to a considerable extent.

September, 1926.

REGIONAL ANATOMY OF THE UPPER LIMB.

Dissection. The skin has to be reflected from the anterior aspect of the chest and the axilla under the supervision of the demonstrator who will make the necessary incisions. The descending cutaneous nerves that stream over the clavicle must be secured. An anterior cutaneous nerve will be found emerging next to the sternum in each of the upper six intercostal spaces except the first. The lateral cutaneous nerves (anterior and posterior branches) on the lateral aspect of the trunk ought also to be secured.

The mamma is usually atrophied in dissecting room subjects. It may be noted, however, that its lobules which are from twelve to twenty in number, are entirely superficial to the deep fascia. The so-called "axillary tail" of the gland extends into the axilla along the lower borders of the pectoral muscles. It contains the efferent lymph vessels from the outer two thirds of the mamma. The ducts from the lobules open on the surface of the nipple.

The axilla or arm pit is a four sided space with a base and an apex. In each wall are found three structures, two of these being muscles The anterior wall is composed of the pectoralis major, pectoralis minor and the costo-coracoid membrane. The posterior wall contains the subscapularis, the tendon of the latissimus dorsi and the teres major. The external wall exhibits the short head of the biceps, the coraco-brachialis and the surgical neck of the humerus, while the serratus magnus and the upper 5 or 6 ribs with their intercostal muscles constitute the internal wall. The base is dome shaped and formed by the skin. The three sided apex is bounded by the clavicle in front, the upper border of the scapula behind and the 1st rib internally (examine these in the skeleton).

The pectoralis major arises from the inner half of the anterior aspect of the clavicle (clavicular head) and from the lateral half of the front of the sternum, the first six costal cartilages and the aponeurosis of the external oblique. Its fibres converge towards their insertion which is into the outer lip of the bicipital groove of the humerus. Its nerve supply is from the external and internal anterior thoracic nerves and its action is to flex and adduct the shoulder joint.

Reflect the pectoralis major from its origin, thus exposing the costo-coracoid membrane and the pectoralis minor. The latter arises from the 3rd, 4th & 5th (may be 2nd, 3rd & 4th) ribs close to their cartilages, and is inserted into the inner border of the coracoid process. Its nerve supply is from the internal anterior thoracic which pierces it, and its action is to depress the scapula. Reflect this muscle from its origin.

The costo-coracoid membrane is a layer of loose connective tissue which fills up the gap between the pectoralis minor and the clavicle to both of which it is attached. It contains one well defined band which passes from the first costal cartilage to the coracoid process. It is pierced by the thoracic axis artery and vein, the cephalic vein, the external anterior thoracic nerve and a few lymph vessels from the mamma.

The contents of the axilla will be next exposed and cleaned. These are the axillary artery and its branches, the axillary vein and its tributaries including the

cephalic vein, the three cords of the brachial plexus and their branches, the nerve to the serratus magnus, the intercosto-brachial nerve, lymphatic glands and vessels and the sheath round the axillary artery.

The axillary artery begins at the outer border of the first rib as a continuation of the subclavian, and after traversing the axilla ends opposite the lower border of the teres major by changing its name into brachial. It is divided for convenience in description into three parts by the pectoralis minor. In front of the first part are the skin, fasciae, pectoralis major, costo-coracoid membrane, cephalic vein and a nerve loop connecting the two anterior thoracic nerves. Behind is the first digitation of the serratus magnus with its nerve of supply. Externally are the three cords of the brachial plexus and internally the axillary vein. In front of the second part of the artery are the skin, fasciae, pectoralis major and pectoralis minor. Behind is the posterior cord of the brachial plexus, to the outside is the outer cord and internally is the axillary vein with the internal cord intervening. In front of the third part of the artery are the pectoralis major, the skin and fasciae, behind are the subscapularis, tendon of latissimus dorsi and teres major, externally are the surgical neck of the humerus with the coracobrachialis and the short head of the biceps, while internally is as usual the axillary vein. In addition two branches of the brachial plexus will be found on each aspect of the third part of the artery. Externally are the musculocutaneous nerve and outer head of the median (the median nerve itself lower down), in front are the inner head of the median and the internal cutaneous nerve of the forearm, behind are the circumflex and musculo-spiral nerves, and internally the ulnar nerve and the internal cutaneous nerve of the upper arm, the latter lying to the inner side of the vein.

The branches of the axillary artery are; the superior thoracic from the first part, the thoracic axis and lateral thoracic from the second part, the alar thoracic, subscapular, anterior circumflex and posterior circumflex from the third part. The superior thoracic is very small and ramifies on the upper end of the serratus magnus. The thoracic axis pierces the costo-coracoid membrane and immediately divides into clavicular, acromial, deltoid and pectoral branches, which supply the clavicular head of the pectoralis major, the tissues over the acromion, the deltoid and the pectoral muscles respectively. The lateral or long thoracic takes its course from the lower border of the pectoralis minor. It supplies the pectoral muscles and the anterior aspect of the chest including the outer two thirds of the mamma in the female. The alar thoracic is an inconstant branch which supplies the lymph glands of the axilla. The subscapular which is the largest branch of the axillary artery takes its course from the axillary border of the scapula and ends at the inferior angle by anastomosing with the posterior scapular artery. It supplies the muscles of the posterior axillary wall and gives off the large dorsalis scapulae which winds round the axillary border under cover of the teres minor and infraspinatus where it ends by anastomosing with the suprascapular and posterior scapular. The same three arteries give off anterior branches which anoatsmose on the anterior aspect of the bone under the subscapularis. The an-

terior and posterior circumflex arteries arise at the same level as the subscapular, and they form an arterial ring round the surgical neck of the humerus. The anterior proceeds outwards under the coraco-brachialis and both heads of the biceps to anastomose under cover of the deltoid with the posterior circumflex. On the way it sends a branch up the bicipital groove into the shoulder joint. The posterior circumflex artery is larger than the anterior. It passes directly backwards through the quadrilateral space in company with the circumflex nerve. It then sweeps forwards round the surgical neck of the humerus, freely supplying the deltoid all the time.

The axillary vein begins at the lower border of the teres major, or perhaps higher up, by the union of the basilic vein with the companion veins of the brachial artery. It runs upwards along the inner aspect of the artery and ends at the outer border of the first rib by changing name into subclavian. Its tributaries correspond to the branches of the artery and it receives in addition the cephalic vein.

The external, internal and posterior cords of the brachial plexus lie together on the outer aspect of the first part of the artery; they arrange themselves according to their names on the corresponding aspect of the second part; while their eight terminal branches are distributed round the third part of the artery as already noted.

The external cord gives off the external anterior thoracic nerve and then divides into the musculo-cutaneous and the outer head of the median. The external anterior thoracic nerve pierces the costo-coracoid membrane and supplies the pectoralis major. The musculo-cutaneous nerve leaves the axilla by piercing the coraco-brachialis and will be studied later.

The internal cord of the plexus gives off the internal anterior thoracic nerve, the internal cutaneous nerve of the upper arm, the internal cutaneous nerve of the forearm and then divides into the ulnar nerve and the inner head of the median. The internal anterior thoracic supplies the pectoralis minor and then pierces this muscle to end in the pectoralis major. The cutaneous nerves of the upper arm and forearm and the ulnar nerve will be studied later.

The posterior cord gives off the superior and inferior subscapular nerves and the nerve to the latissimus dorsi. It then divides into the circumflex and musculo-spiral nerves. The superior subscapular nerve supplies the subscapularis. The inferior subscapular nerve gives a few extra twigs to the subscapularis and then ends in the teres major. The nerve to the latissimus dorsi accompanies the subscapular artery in its course to that muscle. The musculo-spiral nerve will be studied later. The circumflex nerve passes backwards through the quadrilateral space in company with the posterior circumflex artery and gives off a twig to the shoulder joint. It then divides into an anterior branch which proceeds with the artery to supply the deltoid and a posterior division which sends a branch, with a peculiar thickening of its sheath, to the teres minor, and after supplying a few extra twigs to the deltoid sweeps round the posterior edge of that muscle to supply the skin over it.

The intercosto-brachial nerve is the lateral cutaneous branch of the second intercostal nerve. It crosses the axilla to supply the inner aspect of the upper arm, and communicates with the internal cutaneous nerve of the upper arm.

The lymphatic glands are in three groups, one along the main vessels which receives the lymph vessels from the upper limb, one along the lateral thoracic artery which drains the lymph from the anterior chest wall including the outer 2-3 of the mamma and a third group along the subscapular artery which receives the lymph from the back.

THE SUPERFICIAL DISSECTION OF THE BACK.

After reflecting the skin of the back as far as the level of the iliac crest, the dorsal cutaneous nerves are to be looked for close to the middle line of the back. Three are found in the cervical region, twelve in the dorsal region and three in the lumbar region. The trapezius and latissimus dorsi muscles are then to be cleaned.

The trapezius arises from the external occipital protuberance, the inner third of the superior curved occipital line, the ligamentum nuchae, the spines of the seventh cervical and of the twelve dorsal vertebrae with their intervening supraspinous ligaments. The fibres converge towards their insertion which is into the outer third of the posterior aspect of the clavicle, the inner border of the acromion process and the upper border of the spine of the scapula. Its nerve supply is from the accessory nerve and the third and fourth cervical nerves. Its action is to brace the shoulders.

The latissimus dorsi takes origin from the lower six dorsal spines and their supraspinous ligaments, and by means of the lumbar aponeurosis from all the lumbar spines, the back of the sacrum and the posterior third of the iliac crest. It also arises independently from another inch of the iliac crest, from the lower three ribs and the inferior angle of the scapula. Its tendon sweeps round the lower border of the teres major in the posterior axillary fold to obtain insertion into the floor of the bicipital groove. Its nerve is derived from the posterior cord of the brachial plexus. It is the great muscle of swimming and produces the backward sweep of the arm.

On reflecting the trapezius, the levator scapulae, the rhomboideus minor and the rhomboideus major are exposed. The levator scapulae arises from the transverse processes of the upper four cervical vertebrae and is inserted into the superior angle and vertebral border of the scapula as far as the root of the scapular spine. It is supplied by the nerve to the rhomboids and twigs from the third and fourth cervical. It elevates the scapula. The rhomboideus minor arises from the ligamentum nuchae and the spines of the seventh cervical and first dorsal vertebrae. It is inserted opposite the root of the scapular spine. Its nerve supply is from the nerve to the rhomboids, a branch of the fifth cervical nerve, and its action is to pull the scapula upwards and inwards. The rhomboideus major arises from the upper four or five dorsal spines and the intervening supraspinous ligaments. It is inserted into the vertebral border of the scapula between the

spine and the inferior angle. Its nerve supply and its action are the same as those of the minor.

The transverse cervical, a branch of the subclavian, is the artery of this region. It divides into a superficial branch which accompanies the accessory nerve and supplies the trapezius, and a deep branch (posterior scapular) which accompanies the nerve to the rhomboids and supplies the same muscles.

The serratus must be defined and examined before the limb is detached from the trunk. This muscle arises from the outer aspects of the upper eight ribs midway between their angles and anterior ends by nine digitations, two of which take origin from the special tubercle on the second rib. The insertion is along the whole length of the vertebral border of the scapula on its ventral aspect. Its nerve is derived from the fifth, sixth and seventh cervical, and its action is to thrust forward the shoulder girdle, as in boxing.

THE UPPER ARM.

The limb may now be removed from the trunk and the skin reflected half way down the upper arm. The superficial fascia covering the deltoid muscle has to be removed. Secure the cutaneous branch of the circumflex nerve that sweeps round the posterior border of the deltoid.

The deltoid arises from the outer third of the anterior aspect of the clavicle, the tip and outer border of the acromion and the lower border of the spine of the scapula. Its fibres converge towards their insertion into the deltoid eminence of the humerus. Its nerve supply is from the circumflex and its action is to abduct the arm. Note the large subacromial bursa which intervenes between its origin and the shoulder joint. Reflect this muscle from its origin.

The subscapularis arises from the anterior aspect of the scapula except a portion near the neck where a bursa intervenes between the muscle and the shoulder joint. It is inserted into the lesser tuberosity of the humerus. Its nerve supply is from the superior and inferior subscapular nerves and its action is to adduct and inwardly rotate the upper arm.

The teres major arises from the dorsal aspect of the inferior angle and the lower third of the axillary border of the scapula. Its insertion is into the inner lip of the bicipital groove of the humerus. It is supplied by the inferior subscapular nerve. It adducts the upper arm. The teres minor arises from the middle third or so of the axillary border of the scapula, and is inserted into the lowest impression on the great tuberosity of the humerus. Its nerve supply is from the circumflex and its action is to adduct the upper arm.

The supraspinatus arises from the inner two thirds of the supraspinous fossa of the scapula and is inserted into the uppermost impression on the great tuberosity of the humerus. It is supplied by the suprascapular nerve and abducts the arm. The infraspinatus arises from the infraspinous fossa of the scapula and is inserted into the middle impression on the great tuberosity of the humerus. It is supplied by the suprascapular nerve and adducts the arm.

The suprascapular vessels and nerve supply, the supra and infra-spinatus muscles and also articular twigs to the shoulder joint. The suprascapular artery is a branch of the subclavian and enters the scapular region above the suprascapular ligament. It supples the deep surface of the supra-spinatus, passes through the scapular notch, and ends by supplying the infra-spinatus. Its anastomoses with the posterior scapular and dorsalis scapulae arteries on the ventral and dorsal aspects of the scapula have been already studied.

The suprascapular nerve is a branch of the fifth and sixth cervical nerves. It passes under the suprascapular ligament, supplies the supra and infra spinatus and also two articular twigs to the shoulder joint.

The quadrangular space is the gap through which the posterior circumflex artery and the circumflex nerve pass. It is bounded externally by the humerus internally by the long head of the triceps, below by the teres major and abovs by the teres minor when studied from behind (above by the subscapularis when examined from the front).

The triangular space has the same upper and lower boundaries as the quadrilateral from which it is separated by the long head of the triceps which forms its third side. The dorsal artery of the scapula enters it in order to wind round the bone.

THE FRONT OF THE UPPER ARM.

The skin must now be reflected to a point two inches below the level of the elbow The internal cutaneous nerve of the arm, the internal cutaneous branch of the musculo-spiral and the intercosto-brachial nerve will be found on the inner aspect of the arm, while the upper and lower external cutaneous branches of the musculo-spiral nerve will be found in the lower part of the outer aspect of the upper arm.

The external and internal intermuscular septa divide the lower part of the upper arm into anterior and posterior muscular compartments. The anterior contains the biceps, coraco-brachialis and brachialis while the triceps occupies the posterior compartment. Define the anterior group of muscles.

The long head of the biceps arises from the upper end of the glenoid fossa of the scapula and from the glenoid fibro-cartilage. The short head arises from the tip of the coracoid process conjointly with the coraco-brachialis. The two heads unite about the middle of the upper arm and the tendon is inserted into the bicipital tuberosity of the radius. It also sends a strong band, the bicipital fascia, to the deep fascia of the forearm. Its nerve supply is from the musculo-cutaneous and its action is to supinate the hand and flex the elbow. The long head abducts and the short head adducts the arm.

The coraco-brachialis arises from the tip of the coracoid process in common with the short head of the biceps. It is inserted into the inner aspect of the humerus about its middle and it is supplied by the musculo-cutaneous nerve immediately before piercing it. It adducts the arm.

The brachialis arises from the lower half of the anterior aspect of the humerus

and from the internal intermuscular septum. It is inserted into the coronoid process of the ulna. It is supplied by the musculo-spiral and musculo-cutaneous nerves. It flexes the elbow.

The long head of the triceps arises from the axillary border of the scapula immediately below the glenoid fossa. The outer head takes its origin from the posterior aspect of the humerus above the musculo-spiral groove, while the inner head arises below the musculo-spiral groove and also from the external and internal intermuscular septa. The tendon is inserted into the upper and outer aspects of the olecranon process of the ulna. Its nerve supply is from the musculo-spiral and its action is to extend the elbow. The long head also adducts the arm.

The brachial artery begins at the lower border of the teres major as a continuation of the axillary artery. Its course in the upper two thirds is vertically down the inner aspect of the upper arm, while the lower third sweeps downwards and outwards in front of the elbow to terminate opposite the neck of the radius by dividing into radial and ulnar branches. Superficially it is covered all the way by skin, superficial and deep fascia which separates it from the median-basilic vein at the bend of the elbow. It is also overlapped slightly by the biceps. Posteriorly it is in relation with the long and inner heads of the triceps, the insertion of the coraco-brachialis and the brachialis. The median nerve is to the outer side of the artery in its upper part, crosses superficially or deeply at the level of the coraco-brachialis insertion and then lies to the inner side. The ulnar nerve and the internal cutaneous lie along the inner side of the artery as far as the coraco-brachialis insertion. There they leave it, the former by piercing the internal intermuscular septum and the latter by piercing the deep fascia. The musculo-spiral nerve runs down behind the upper part of the artery in company with its superior profunda branch but soon leaves it in company with that vessel. The brachial artery is accompanied throughout its course by two companion veins and along the inner side in its upper half by the basilic vein as well.

The branches of the brachial artery are superior profunda, inferior profunda, nutrient, anastomotic and muscular branches. The superior profunda arises an inch below the origin and at once associates itself with the musculo spiral nerve in company with which it sweeps downwards and outwards behind the humerus in the musculo-spiral groove, supplying twigs to the triceps. On reaching the outer aspect of the upper arm it divides into anterior and posterior branches. The latter runs down behind the external condyle of the humerus to anastomose with the interosseous recurrent artery while the anterior branch pierces the external intermuscular septum in company with the musculo-spiral nerve, and anastomoses in front of the external condyle with the radial recurrent artery. The inferior profunda arises just below the superior and very often in conjunction with it. The artery at once accompanies the ulnar nerve through the internal intermuscular septum to the posterior compartment of the arm, where it supplies the triceps and ends by anastomosing with the posterior ulnar recurrent. The nutrient artery to the humerus arises opposite the coraco-brachialis insertion

and enters the nutrient foramen of the bone which is situated at this level. The anastomotic branch comes off about two inches above the bend of the elbow and runs inwards upon the brachialis where it soon divides into posterior and anterior branches which anastomose with the posterior and anterior ulnar recurrent arteries behind and in front of the internal condyle respectively. The muscular branches of the brachial artery pass to the muscles of the anterior compartment of the upper arm.

The musculo-cutaneous nerve after its origin from the outer cord of the brachial plexus pierces the coraco-brachialis, and passes downwards and outwards between the biceps and brachialis to the bend of the elbow where it pierces the deep fascia just external to the biceps tendon. It ends by dividing into anterior and posterior cutaneous branches which supply the anterior and posterior aspects of the skin of the forearm as far as the hand. The musculo-cutaneous nerve also supplies the coraco-brachialis, biceps and brachialis, the latter partially.

The musculo-spiral nerve arises from the posterior cord of the brachial plexus. It runs down behind the third part of the axillary artery and the beginning of the brachial where it joins the superior profunda artery and winds round the back of the humerus with this vessel in the musculo-spiral groove. It pierces the external inter-muscular septum and runs down between the brachialis internally and the brachio-radialis and extensor carpi radialis longus externally. In front of the external condyle it ends by dividing into the radial and posterior interosseous nerves. The musculo-spiral nerve supplies the triceps, brachialis (partially), brachio-radialis, extensor carpi radialis longus and anconeus (partially). High up it gives off its internal cutaneous branch which supplies the inner and back part of the upper arm as far as the elbow. Externally it has the upper and lower external cutaneous branches, of which the former supplies the outer aspect of the upper arm as far as the elbow and the latter the posterior aspect of the forearm as far as the wrist. It should be noted that one of the muscular branches to the inner head of the triceps is frequently adherent to the sheath of the ulnar nerve and has on that account been termed the ulnar collateral nerve.

THE FRONT OF THE FOREARM.

The skin must now be reflected from the front of the forearm as far as the wrist. Running up the middle of the front of the forearm in the superficial fascia will be found the median vein which is joined just below the bend of the elbow by the profunda vein, the latter emerging through the deep fascia for that purpose. The median vein then divides into the median-basilic and the median-cephalic which pass inwards and outwards respectively to join the ulnar and radial superficial veins which course up the corresponding margins of the forearm after draining the venous arch on the dorsum of the hand. By these unions the ulnar and radial veins become the basilic and cephalic veins, and run upwards on the inner and outer aspects of the biceps respectively. The basilic pierces the deep

fascia of the upper arm at the level of the insertion of the coraco-brachialis and its termination in the axillary vein has been already noted. The cephalic vein also joins the axillary vein as previously shown.

The cutaneous nerves on the anterior aspect of the forearm are the anterior terminal branches of the musculo-cutaneous and internal cutaneous nerves. Remove the superficial fascia and clean the muscles on the front of the forearm.

The antecubital fossa is a triangular space situated in front of the bend of the elbow. It is bounded externally by the brachio-radialis and internally by the pronator teres, while the base is an imaginary line drawn through the condyles of the humerus. The roof is formed by the deep fascia which is thickened by the bicipital fascia and pierced by the profunda vein. The floor is composed of the brachialis and supinator muscles. The contents are the division of the brachial artery into its radial and ulnar branches, the median nerve and the tendon of the biceps. Of these the brachial artery is intermediate in position, while the nerve lies internally and the biceps tendon externally. On lifting the outer and inner boundaries of the space the radial recurrent and anterior ulnar recurrent arteries may be seen.

The muscles on the front of the forearm are arranged in a superficial and a deep group. The superficial muscles, five in number, are named from the radial to the ulnar side as follows--the pronator teres, the flexor carpi radialis, the palmaris longus (sometimes absent) the flexor sublimis digitorum and the flexor carpi ulnaris. All the superficial muscles have a common origin from the internal condyle of the humerus. The three deep muscles are the flexor longus pollicis, the flexor profundus digitorum and the pronator quadratus. All these muscles are supplied by the median nerve except 1½ (Flexor Carpi ulnaris and inner half of the flexor profundus digitorum which are supplied by the ulnar nerve). The pronator teres in addition to the common origin from the internal condyle of the humerus, also arises from the coronoid process of the ulna. Between the two heads will be found the median nerve. The muscle is inserted into the outer aspect of the radius about its middle. It is supplied by the median nerve. Its action is to flex the elbow and pronate the hand.

The flexor carpi radialis arises from the internal condyle of the humerus, from the investing deep fascia and from the septa on either side. Its tendon grooves the trapezium and is inserted into the bases of the second and third metacarpal bones on their palmar aspects. Its nerve is the median and it flexes the elbow and wrist.

The palmaris longus arises from the common origin, the deep fascia and the septa on either side. Its tendon passes in front of the anterior annular ligament to be inserted into the palmar fascia and the short muscles of the thumb. Its nerve is the median and it flexes the elbow and wrist.

The flexor sublimis digitorum in addition to the common humerus origin also arises from the internal ligament of the elbow, the coronoid process of the ulna, the oblique line of the radius and the anterior border of the radius for two inches. The four tendons pass to the fingers and each will be found to split to allow the

flexor profundus tendon to pass. After reuniting, they split again to be inserted into the lateral margins of the second phalanges of the fingers. Its nerve supply is the median and it flexes the elbow, wrist and the two proximal joints of the fingers.

The flexor carpi ulnaris arises from the common origin and also from the inner edge of the olecranon process and the upper two-thirds of the posterior border of the ulnar. The ulnar nerve enters the forearm between these two heads. The tendon is inserted into the pisiform bone and the nerve supply is from the ulnar. Its action is to flex and adduct the wrist.

The flexor longus pollicis arises from the middle two-fourths of the anterior aspect of the radius and also slightly from the interosseous membrane. It has an occasional origin from the coronoid process of the ulna. Its tendon is inserted into the palmar aspect of the distal phalanx of the thumb. It is supplied by the anterior interosseous branch of the median and its action is to flex the wrist and all the joints of the thumb.

The flexor profundus digitorum takes origin from the upper three fourths of the anterior and inner aspects of the ulna and also slightly from the interosseous membrane. The four tendons are inserted into the palmar aspects of the distal phalanges of the fingers. Its nerve supply is from the ulnar and the anterior interosseous. Its action is to flex the wrist and all the joints of the fingers.

The pronator quadratus arises from the pronator ridge on the lower fourth of the anterior aspect of the ulna and is inserted into the anterior aspect of the radius in its lower fourth. It is supplied by the anterior interosseous branch of the median and its action is to pronate the hand.

The radial artery begins in the antecubital fossa opposite the neck of the radius as the smaller terminal branch of the brachial with which its course is directly continuous. It runs almost vertically downwards on the outer part of the front of the forearm to the wrist, round the outer aspect of which it winds to reach the back of the hand. In the forearm its posterior relations from above downwards are, the tendon of the biceps, the supinator, the insertion of the pronator teres, the flexor sublimis digitorum, the flexor longus pollicis, the pronator quadratus and the lower end of the radius. It is overlapped in its upper third by the brachio-radialis but is merely covered by the skin and fasciae in its lower two thirds, thus providing a favourable site for examining the pulse. It is accompanied by two companion veins, and the radial nerve lies along its outer aspect in the middle third.

The branches of the radial artery in this part of its course are, the radial recurrent, muscular branches, superficial volar and anterior radial carpal. The radial recurrent arises just below the origin and turns upwards in front of the external condyle of the humerus to anastomose with the superior profunda artery. The muscular branches arise all the way down. The superficial volar arises at the wrist and after supplying the muscles of the ball of the thumb anastomoses with the superficial palmar arch. The anterior radial carpal artery also arises opposite the wrist and runs inwards under the flexor tendons to anastomose with the anterior ulnar carpal, thus completing the anterior carpal arch.

The ulnar artery is the larger terminal branch of the brachial and runs downwards and inwards in the upper third of its course in order to reach the inner part of the front of the forearm in the lower two thirds of which it runs vertically downwards to enter the hand in front of the transverse ligament just external to the pisiform bone. From above downwards its posterior relations in the forearm are, the brachialis, the flexor profundus digitorum (nearly all the way) and the transverse ligament. The upper oblique third of its course is crossed superficially by the pronator teres, flexor carpi radialis, palmaris longus and flexor sublimis digitorum. The lower two thirds are overlapped by the flexor carpi ulnaris. The artery as it lies on the transverse ligament is protected by a special slip of strong fascia. Two companion veins accompany the artery and the ulnar nerve lies along its inner side in the lower two thirds of its course. The median nerve crosses it superficially close to its origin but is separated from it by the coronoid head of the pronator teres.

The branches of the ulnar artery in the forearm are, anterior and posterior ulnar recurrent, the common interosseous, muscular branches, and the anterior and posterior ulnar carpal. The anterior ulnar recurrent arises close to the origin and turns upwards in front of the internal condyle to anastomose with the anastomotic. The posterior ulnar recurrent is rather larger than the anterior and may arise by a common stem. It turns upwards behind the internal condyle to anastomose with the anastomotic and inferior profunda.

The common interosseous takes origin immediately below the posterior ulnar recurrent and almost immediately divides into anterior and posterior interosseous. The former runs downwards in front of the interosseous membrane in company with the anterior interosseous nerve and between the flexor longus pollicis and flexor profundus digitorum. At the upper border of the pronator quadratus it pierces the interosseous membrane and runs down on the back of the wrist to join the posterior carpal arch. It gives off muscular branches, the nutrient arteries to the radius and ulna and a communicating branch which runs down underneath the pronator quadratus to join the anterior carpal arch. A small branch may often be found accompanying the median nerve. The posterior interosseous artery enters the posterior aspect of the forearm over the upper border of the interosseous membrane and runs downwards between the superficial and deep groups of extensor muscles to the back of the wrist where it joins the posterior carpal arch. It is accompanied a short distance by the posterior interosseous nerve. It supplies the extensor muscles and an interosseous recurrent branch which turns upwards underneath the anconeus to anastomose with the superior profunda artery.

The anterior and posterior ulnar carpal arteries pass outwards on the carpus underneath the flexor and extensor tendons respectively, to anastomose with the anterior and posterior radial carpal arteries, thus completing the anterior and posterior carpal arches.

The median nerve enters the forearm between the two heads of the pronator teres. It courses vertically downwards between the flexor sublimis and flexor

profundus digitorum and enters the hand under cover of the transverse ligament of the wrist. It supplies the pronator teres, the flexor carpi radialis, the palmaris longus and flexor sublimis digitorum. It then gives off the anterior interosseous nerve which accompanies the vessels of the same name and supplies the flexor longus pollicis, the pronator quadratus and the outer half of the flexor profundus digitorum. Just above the wrist the median nerve gives off a minute palmar cutaneous branch to the skin of the palm.

The ulnar nerve enters the forearm between the two heads of the flexor carpi ulnaris and runs downwards upon the flexor profundus digitorum. In the lower two thirds of the forearm this nerve lies along the inner side of the ulnar vessels. It then enters the palm by passing superficial to the transverse ligament of the wrist just external to the pisiform bone. In the forearm the ulnar nerve is overlapped throughout its course by the flexor carpi ulnaris. It supplies this muscle and also the inner half of the flexor profundus digitorum. In addition it gives an articular twig to the elbow joint, a dorsal cutaneous branch to the back of the hand and a palmar cutaneous twig to the skin of the palm.

THE HAND.

The ball of the thumb or volar eminence is produced by three muscles—the abductor, flexor brevis and opponens pollicis. The projection along the inner edge of the palm is also produced by three muscles—the abductor, flexor brevis and opponens minimi digiti.

After removing the skin and superficial fascia from the palm it will be noticed that the central hollow portion is covered by the very strong palmar fascia. This is attached above to the transverse ligament and also gives insertion to the tendon of the palmaris longus. When traced towards the fingers the fascia will be found to divide into four slips which are attached to the sheaths of the flexor tendons at the roots of the fingers.

On removing the palmar fascia the superficial palmar arterial arch will be exposed. This lies in a line with the lower border of the outstretched thumb. The arch is completed internally by the superficial branch of the ulnar artery and externally by the superficial volar, the radialis indicis, or the princeps pollicis branches of the radial artery. The superficial palmar arch rests upon the digital branches of the median nerve and the tendons of the flexor sublimis digitorum. It gives off four digital arteries, of which the innermost supplies the inner margin of the little finger while each of the other three divides into two branches, which supply the adjacent margins of the index, middle, ring and little fingers. It should be noted that these vessels also supply the dorsal aspects of the last segments of the fingers including the bed of the nail.

Reflect the skin from the palmar aspects of the fingers and thumb and trace these digital arteries to their termination. It will be noticed that the accompanying digital nerves lie directly in front of these. A little further dissection will expose the sheaths of the flexor tendons. On slitting these open the tendons of

the flexor sublimis and flexor profundus digitorum will be released. These can now be traced to their insertions.

The median nerve enters the hand under cover of the transverse ligament and immediately gives off branches to the three muscles of the ball of the thumb. It then divides into external and internal divisions of which the external sends branches to both sides of the thumb and to the radial side of the index finger; while the internal division again divides into two branches to supply the adjacent margins of the index, middle and ring fingers. The nerve to the radial side of the index finger gives a twig to the first lumbrical muscle, while the nerve to the ulnar side of this supplies the second lumbrical muscle.

The ulnar nerve enters the hand in front of the transverse ligament along with the vessels and soon divides into superficial and deep branches. The superficial branch passes downwards under the palmaris brevis muscle (a collection of muscle fibres attached to the skin along the inner edge of the palm) and then divides into inner and outer branches. The inner supplies the ulnar margin of the little finger, while the outer divides to supply the adjacent margins of the ring and little fingers, and usually sends a communicating branch to the median nerve.

The transverse or anterior annular ligament of the wrist is attached externally to the tubercle of the scaphoid and the ridge on the trapezium, and internally to the pisiform and the hook of the unciform. Two synovial sheaths lie under cover of it, of which the outer encloses the tendon of the flexor longus pollicis, while the inner is wrapped round the tendons of the flexor sublimis and flexor profundus digitorum. Between these two synovial sheaths the median nerve lies. These synovial sacs extend about two inches above the wrist. The one enclosing the flexor longus pollicis tendon is continued down to its insertion and therefore lines the flexor sheath of the thumb. The synovial sac round the sublimis and profundus tendons is continued down to the middle of the palm, but in the case of the little finger is prolonged as far as the insertion of these tendons.

The flexor sheaths are composed of dense fibrous tissue and are attached to the margins of the phalanges of the thumb and fingers. They therefore form fibrous tunnels which maintain the flexor tendons in close contact with the phalanges during flexion of the fingers. Their fibrous walls are much thinned opposite the inter-phalangeal joints. They are lined by synovial membrane which sends loop like folds round the flexor tendons. As already mentioned, this synovial membrane is continuous with that under the transverse ligament of the wrist, only in the case of the thumb and little finger.

The transverse ligament of the wrist and the flexor tendons will now have to be cut in order to expose the deep palmar arterial arch and the deep branch of the ulnar nerve.

The deep palmar arch rests upon the bases of the metacarpal bones. It is formed externally by the radial artery and is completed internally by the deep branch of the ulnar artery. It gives off three palmar interosseous branches which anastomose with the digital branches of the superficial arch, three perforating arteries which pass backwards between the metacarpal bones to anastomose

with the dorsal interosseous arteries, and two or three recurrent twigs which anastomose with the anterior carpal arch.

The deep branch of the ulnar nerve accompanies the deep palmar arch and at once breaks up into numerous branches which supply the seven interosseous muscles, the two inner lumbrical muscles, the deep head of the flexor brevis pollicis, the two adductors of the thumb, the abductor minimi digiti, the flexor brevis minimi digiti and the opponens minimi digiti.

The four lumbrical muscles take origin from the tendons of the flexor profundus digitorum, the first and second each arising from one tendon, the third and fourth each from two. Each winds round the radial margin of the corresponding finger to be inserted into the extensor tendon.

The abductor pollicis takes origin from the scaphoid and the transverse ligament. It is inserted into the outer side of the base of the proximal phalanx of the thumb. Its nerve supply is the median.

The flexor brevis pollicis and the opponens pollicis possess a common origin from the ridge on the trapezium and the transverse ligament. The flexor brevis is inserted in common with the abductor while the opponens obtains attachment to the radial border of the first metacarpal. Their nerve supply is from the median.

The abductor minimi digiti obtains origin from the pisiform and the transverse ligament. It is inserted into the inner side of the base of the proximal phalanx of the little finger. Its nerve supply is the deep branch of the ulnar.

The flexor brevis and the opponens minimi digiti have a common origin from the transverse ligament and from the hook of the unciform. The flexor brevis is inserted along with the abductor while the opponens obtains insertion along the ulnar border of the fifth metacarpal. Their nerve supply is from the deep branch of the ulnar.

The adductors of the thumb when defined will be found to consist of oblique and transverse fibres. The former arise from the trapezium, trapezoid, the os magnum and the bases of the second and third metacarpals, while the transverse fibres, spring from the lower two-thirds of the shaft of the third metacarpal. The fibres are all inserted into the inner side of the base of the proximal phalanx of the thumb. The nerve supply is from the deep division of the ulnar nerve.

THE BACK OF THE FOREARM AND HAND.

The skin may now be removed from the back of the forearm and hand. The posterior cutaneous branches of the musculo-cutaneous, the musculo-spiral and the internal cutaneous nerves must be defined on the back of the forearm.

The venous arch on the dorsum of the hand receives most of the blood from the thumb and fingers. Its outer end is drained by the radial and its inner end by the two ulnar veins. Their course and termination have been already studied.

The radial nerve will be found on the dorsum of the hand, where it divides into five branches which supply respectively the two margins of the thumb, the radial margin of the index and the adjacent margins of the index, middle and ring

fingers. The inner one and a half fingers are supplied by the dorsal branch of the ulnar nerve, one twig passing along the inner margin of the little finger while the other passes to supply the adjacent margins of the little and ring fingers.

The deep fascia on the back of the forearm and hand is well marked and is specially thickened on the back of the wrist to form the annular ligament which is attached externally to the lower end of the radius and internally to the cuneiform and pisiform. It possesses six compartments for the passage of the extensor tendons. On opening these up after cleaning the muscles, it will be noted that the first or radial compartment transmits the tendons of the abductor longus pollicis and the extensor brevis pollicis, the second contains the tendons of the extensor carpi radialis longus and brevis, the third is occupied by the tendon of the extensor longus pollicis, the fourth transmits the tendons of the extensor communis digitorum and the extensor indicis and the interosseous vessels of the forearm, the fifth contains the tendon of the extensor minimi digiti and the sixth the tendon of the extensor carpi ulnaris.

The muscles on the back of the forearm are arranged in a superficial and a deep group. The superficial group is named as follows from the radial side—brachio-radialis, extensor carpi radialis longus, extensor carpi radialis brevis, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris and the anconeus.

The brachio-radialis arises from the upper two thirds of the external supracondylar ridge of the humerus and the fascia. It is inserted into the outer aspect of the lower end of the radius at the root of the styloid process. Its nerve supply is the musculo-spiral and its action is to flex the elbow.

The extensor carpi radialis longus takes origin from the lower one third of the external supracondylar ridge of the humerus and the fascia. It is inserted into the base of the second metacarpal bone. Its nerve supply is from the musculo-spiral and its action is to extend the wrist.

The remaining five superficial muscles arise from the external condyle of the humerus, the deep fascia and their intervening septa.

The extensor carpi radialis brevis is inserted into the base of the third metacarpal bone. Its nerve supply is from the posterior interosseous and its action is to extend the wrist.

The extensor communis digitorum is inserted by four tendons, each of which forms an expansion on the dorsal aspect of the first phalanx of each finger. This expansion then splits into three slips of which the middle is inserted into the second phalanx while the others unite to obtain insertion into the distal phalanx. These tendons form the dorsal ligaments for the joints of the fingers. It should be noted that the tendon to the ring finger is connected with those on either side by lateral slips. This muscle is supplied by the posterior interosseous nerve and its action is to extend the metacarpo-phalangeal joints of the fingers, the other two joints of each finger being extended by the pull of the interossei muscles and the lumbricals upon the extensor tendon beyond this joint.

The tendon of the extensor minimi digiti divides into two slips which unite with the tendon of the extensor communis digitorum that goes to the little finger.

This muscle obtains its nerve supply from the posterior interosseous and its action is to extend the little finger at its metacarpo-phalangeal joint.

The tendon of the extensor carpi ulnaris is inserted into the base of the fifth metacarpal bone. This muscle is supplied by the posterior interosseous nerve and its action is to extend the wrist.

The anconeus is inserted into the upper fourth of the posterior surface of the ulna. Its nerve supply is derived from the musculo-spiral and posterior interosseous nerves and its action is to extend the elbow.

The muscles of the deep layer on the back of the forearm are five in number the abductor longus pollicis, the extensor brevis pollicis, the extensor longus pollicis, the extensor indicis and the supinator.

The abductor longus pollicis arises from the middle third of the posterior surface of the radius, from the posterior surface of the ulna just below the insertion of the anconeus and from the interosseous membrane. Its tendon is inserted into the radial side of the base of the first metacarpal bone. Its nerve supply is from the posterior interosseous and its action is to abduct the thumb.

The extensor brevis pollicis arises from the lower third of the posterior surface of the radius and from the interosseous membrane. Its tendon is inserted into the base of the proximal phalanx of the thumb. Its nerve supply is derived from the posterior interosseous and its action is to extend the first two joints of the thumb.

The extensor longus pollicis arises from the posterior surface of the ulna just above the extensor indicis and from the interosseous membrane. It is inserted into the base of the distal phalanx of the thumb. Its nerve supply is from the posterior interosseous and its action is to extend all the joints of the thumb.

The extensor indicis arises from the lower fourth of the posterior surface of the ulna and from the interosseous membrane. It ends by blending with the tendon to the index finger from the extensor communis digitorum. Its nerve supply is from the posterior interosseous.

The supinator muscle arises from the orbicular ligament of the radius and a special hollow on the ulna just below this. The muscle fibres pass outwards to be inserted round the neck of the radius and into the V shaped area on this bone that is mapped out by the anterior and posterior oblique lines. Its nerve supply is from the posterior interosseous and its action is to supinate the hand.

The posterior interosseous nerve is one of the terminal branches of the musculo-spiral. It reaches the back of the forearm by piercing the supinator muscle and becomes associated with the interosseous vessels. It supplies all the muscles on the back of the forearm except the brachio-radialis, the extensor carpi radialis longus and half of the anconeus. Its terminal filaments supply the carpal joints.

The radial artery reaches the back of the hand by winding round the carpus close to the root of the thumb. It passes between the heads of the first dorsal interosseous muscle in order to reach the palm where it ends by joining the deep palmar arch. On the dorsum of the hand it is crossed superficially by the tendons

of the abductor longus pollicis, the extensor brevis pollicis and the extensor longus pollicis. In this part of its course the artery gives off two small dorsal arteries to the thumb, a small dorsal artery to the index finger and the posterior radial carpal which joins the posterior ulnar carpal artery to form the posterior carpal arch. The latter arterial arch is situated upon the dorsal aspect of the distal row of carpal bones and gives off three dorsal interosseous arteries which run downwards to supply the inner three and a half fingers. Just as the radial artery is entering the palm it gives off the princeps pollicis, which divides to supply both sides of the thumb, and the radialis indicis which supplies the radial side of the index finger. These two arteries have been already shown to form an anastomosis with the superficial palmar arch.

The interosseous muscles consist of four dorsal and three palmar. The dorsal muscles arise from the metacarpal bones between which they lie. They abduct the fingers from an imaginary line drawn through the middle digit, and they are inserted partly into the extensor tendons and partly into the bases of the proximal phalanges of the fingers. The first is inserted into the outer side of the index finger, the second and third into each side of the middle finger and the fourth into the inner side of the ring finger.

The palmar interosseous muscles are three in number, and each arises from the metacarpal bone of the finger upon which it acts. They adduct the fingers towards a line drawn through the middle digit. The first is attached to the inner side of the index finger, the second to the outer side of the ring finger and the third to the outer side of the little finger. The interosseous muscles are all supplied by the deep branch of the ulnar nerve.

The deep head of the flexor brevis pollicis is the name given to a small muscle found under cover of the first dorsal interosseous muscle. It arises from the base of the first metacarpal bone and is inserted into the base of the first phalanx of the thumb along with the adductors. It is supplied by the deep branch of the ulnar nerve.

Note that the skin on the dorsal aspect of the distal phalanx of every digit, including the bed of the nail, is supplied by blood vessels and nerves from the palmar aspect of the hand. Therefore the cutaneous vessels and nerves on the dorsal aspect of each digit do not usually cross the line of the distal joint.

THE REGIONAL ANATOMY OF THE LOWER LIMB.

After the skin has been reflected from the upper half of the front of the thigh under the supervision of the demonstrator who will make the requisite incisions, the following cutaneous nerves will be found in the superficial fascia—the external, intermediate and internal cutaneous nerves of the thigh. Their relative positions are indicated by their names, and they can be traced downwards in a vertical direction as far as the patella. Two smaller cutaneous nerves should also be looked for. These are the ilio-inguinal which emerges through the subcutaneous inguinal ring, and the genito-femoral nerve which pierces the deep

fascia just below the centre of the inguinal ligament. The long saphenous vein will be observed running upwards in the inner part of the dissection.

The superficial inguinal lymph glands are of clinical importance. They are arranged in upper and lower groups. The upper group lies along the line of the inguinal ligament and receives the lymph from the external genitals. The lower group is placed along the upper end of the long saphenous vein and drains the lymph from the skin and superficial fascia of the whole lower limb.

The deep fascia is well developed in this region. Towards the outer side of the thigh it becomes thickened into a strong aponeurosis termed the fascia lata which extends from the iliac crest down to the tibia and fibula and receives towards its upper end the insertions of the gluteus maximus and tensor fasciae femoris muscles. The deep fascia of the front of the thigh is pierced by an opening for the long saphenous vein termed the saphenous opening. This is situated just below the inner end of the inguinal ligament. The opening is vertically oval, in shape, is about one inch long, and is bounded externally by a sharp falciform edge, the upper end of which is attached to the inner extremity of the inguinal ligament. Besides the long saphenous vein, a few superficial inguinal veins and lymphatic vessels will be found passing through the opening. The deep fascia may now be carefully removed, in order to define the muscles.

The femoral triangle will now be exposed. Its base is above and is formed by the inguinal ligament. The sartorius muscle constitutes its outer border, while the inner boundary is formed by the inner edge of the adductor longus muscle. The triangle occupies approximately the upper third of the front of the thigh. Its floor is formed from without inwards by the ilio-psoas, the pectineus, and the adductor longus muscles. The roof, as already shown, is formed by the deep fascia, which is pierced by the saphenous opening. The contents are (1) The upper half of the femoral artery and its branches; (2) The upper half of the femoral vein and its tributaries including the termination of the long saphenous vein; (3) The femoral nerve and its branches; (4) The external cutaneous and genito-femoral nerves before they pierce the deep fascia; (5) Some lymphatic glands; (6) The femoral sheath.

The femoral artery begins behind the inguinal ligament at a point midway between the anterior superior iliac spine and the symphysis pubis, as a continuation of the external iliac artery. A line from this point to the prominent internal condyle of the femur approximately indicates the course of the artery. At the apex of the femoral triangle it disappears into the adductor canal. Posteriorly this part of the artery will be seen to rest on the tendon of the psoas, the pectineus, and the adductor longus from above downwards; while superficially it is covered merely by the skin and fasciae. The upper ends of both artery and vein are invested by the dense femoral sheath. The nerve to the pectineus will be found passing inwards behind the upper end of the artery. The femoral vein lies internal to the artery at the inguinal ligament, but comes to lie directly posterior at the apex of the femoral triangle. The femoral nerve and its branches lie to the outer side of the artery.

The branches of the upper half of the femoral artery in order of origin are (1) The superficial inguinal vessels. (2) The deep external pudendal. (3) The profunda femoris. (4) Muscular branches. The inguinal vessels arise just below the ligament, and of these the superficial external pudendal runs inwards to the genitals, the superficial epigastric supplies the anterior abdominal wall and the superficial circumflex iliac supplies the subcutaneous tissues over the region of the iliac crest. The deep external pudendal arises just below the preceding, and courses inwards on the floor of the femoral triangle to supply the genitals. The profunda femoris artery will be studied later.

The femoral sheath invests the upper ends of the femoral vessels and is composed of strong fibrous tissue. It extends downwards upon the artery for 1½ inches, but its inner part is prolonged below the level of the inguinal ligament to the extent of half an inch only. Its anterior wall is continuous above with the fascia transversalis of the anterior abdominal wall, while its posterior wall is continuous with the fascia covering the ilio-psoas. The femoral sheath presents three compartments, of which the outer contains the femoral artery and the genito-femoral nerve, and the middle contains the femoral vein and a few lymph vessels. The inner compartment, which is half an inch long, is termed the femoral canal. It normally transmits lymph vessels and contains some adipose tissue, but may contain a femoral hernia. On passing the finger up the canal it will be noted that the upper end is limited by a ring, the femoral ring. This is bounded in front by the inguinal ligament, internally by the sharp edge of the lacunar ligament, behind by the pubic bone, and externally by the femoral vein. This is the point where a femoral hernia becomes strangulated, and in relieving this the surgeon is liable to cut the abnormal obturator artery which crosses the femoral ring in about 30% of individuals.

The skin must be reflected from the lower half of the front of the thigh and the cutaneous nerves now traced to their final terminations. In addition the patellar branch of the long saphenous nerve will be found curving forwards on the inner aspect of the knee. The prepatellar bursa that lies over the lower part of the patella ought also to be looked for. Chronic inflammatory enlargement of this produces the condition known as "housemaid's knee". The sartorius should now be cleaned. On lifting up this muscle a dense fibrous membrane will be observed covering the femoral vessels. This is the fascial roof of the adductor canal. Incise this and define the contents of the canal.

The adductor canal (Hunter's canal) is situated on the inner aspect of the middle third of the thigh. Its outer wall is formed by the vastus internus while its postero-internal boundary is composed of the adductors longus and magnus. The roof is a dense layer of fascia stretching between the lateral boundaries. On this rests the sartorius muscle, a minute plexus of nerves intervening. The upper end of the canal is continuous with the apex of the femoral triangle and receives the femoral vessels, while at the lower end is the opening in the adductor magnus through which these vessels pass into the popliteal space. The contents of the adductor canal are—(1) The lower half of the femoral artery and its

branches. (2) The lower half of the femoral vein and its tributaries. (3) The long saphenous nerve and the nerve to the vastus internus.

The relations of the femoral artery in the adductor canal are now obvious. In front are the fascial roof of the canal and the sartorius, while on either side are the lateral boundaries. The femoral vein lies on its postero-external aspect, while the long saphenous nerve runs downwards directly in front of it. The artery leaves the adductor canal and enters the popliteal space through the opening in the adductor magnus, and becomes the popliteal artery. The branches of the femoral artery in the adductor canal consist of a few muscular twigs and the anastomotic branch, which arises at the lower end of the canal. This vessel soon divides into a superficial and a deep branch, of which the former escapes from the lower end of the canal along with the long saphenous nerve, and supplies the inner aspect of the knee region; while the deep branch courses downwards in the substance of the vastus internus to join the patellar anastomosis.

The femoral vein begins at the opening in the adductor magnus as a continuation of the popliteal. At first it lies on the postero-external aspect of the artery, at the apex of the femoral triangle it lies directly posterior, and at the inguinal ligament it lies internal. Here it becomes continuous with the external iliac vein. Its tributaries correspond to the branches of the artery, and it also receives the long saphenous vein.

The sartorius muscle arises from the anterior superior iliac spine and slightly from the notch below this. It sweeps diagonally across the front of the thigh and is inserted into the inner surface of the tibia at the level of the anterior tubercle. Its nerve supply is from the femoral, and its action is to flex the hip and knee, and also rotate the thigh outwards, and the leg inwards.

The adductor muscles of the thigh are arranged in three layers—the most anterior consisting of the pectineus and the adductor longus, the intermediate layer being represented by the adductor brevis and the posterior layer by the adductor magnus. Running vertically downwards on the inner aspect of these three layers is the adductor gracilis.

The pectineus takes origin from the ascending ramus of the pubis in front of the ilio-pectineal line between the pubic spine and the ilio-pectineal eminence. Its fibres run downwards and outwards to be inserted into an oblique line extending from the lesser trochanter to the linea aspera of the femur. It is supplied by the femoral nerve and perhaps by the obturator. Its action is to flex and adduct the thigh.

The adductor longus arises from the upper half of the anterior surface of the pubis. Its fibres run downwards and outwards to be inserted into the inner lip of the linea aspera. Its nerve supply is from the obturator and its action is to adduct the thigh.

The adductor brevis arises from the lower half of the front of the pubis and slightly from its descending ramus. The muscle is inserted into the upper end of the linea aspera between the adductors longus and magnus. Its nerve supply is from the obturator and its action is to adduct the thigh.

The adductor magnus takes origin from the outer surfaces of the descending ramus of the pubis and the ramus of the ischium, and also from the lower portion of the ischial tuberosity. The muscle is inserted into the whole length of the linea aspera, while the ischial fibres form a special tendon which obtains insertion into the adductor tubercle of the femur. There is thus an opening between the two portions of the muscle, through which the femoral vessels reach the popliteal space. The muscle is supplied by the obturator and sciatic nerves. Its action is to adduct the thigh and extend the hip.

The adductor gracilis arises from the inner edge of the pubis by the side of the symphysis and also slightly from its descending ramus. Its tendon is inserted into the inner surface of the tibia under cover of the sartorius, and just above the semitendinosus. Its nerve supply is from the obturator and its action is to adduct the thigh.

The obturator externus muscle may be studied at this stage. It arises from the margin of the obturator foramen, except above, and from the superficial surface of the obturator membrane. Its tendon proceeds outwards behind the neck of the femur to obtain insertion into the trochanteric fossa. Its nerve supply is from the obturator and its action is to rotate the thigh outwards.

The profunda femoris artery can now be fully exposed. It arises from the postero-external aspect of the femoral artery 1½ inches below the inguinal ligament. It proceeds downwards and inwards behind the femoral vessels and then passes under cover of the insertion of the adductor longus. It ends in the lower part of the thigh as the fourth perforating artery. Posteriorly the profunda femoris rests upon the ilio-psoas, pectineus, adductor brevis and adductor magnus from above downwards. Its branches are (1) the external circumflex. (2) the internal circumflex. (3) the four perforating arteries. (4) muscular branches.

The external circumflex artery arises close to the origin of the profunda and proceeds outwards under cover of the sartorius and rectus femoris. It soon divides into ascending, transverse and descending branches. The ascending branch runs upwards under cover of the tensor fasciae femoris to anastomose with the superior gluteal artery. The transverse branch winds round the outer side of the femur in the substance of the vastus externus and anastomoses with the internal circumflex. The descending branch runs downwards in the vastus externus in company with the nerve to this muscle, and joins the patellar anastomosis.

The internal circumflex artery is directed backwards from its origin, which is close to that of the external circumflex. It passes first between the psoas and the pectineus, then between the obturator externus and the adductor brevis. Its transverse and ascending terminal branches will be found later in the dissection of the gluteal region appearing at the lower and upper borders of the quadratus femoris. This artery, in addition to muscular branches, supplies a twig to the hip joint.

The four perforating arteries are recognized from the fact that they pass backwards by the side of the femur through tendinous arches in the adductor

muscles. The first and second pierce the adductors brevis and magnus, while the third and fourth pierce the magnus only. They end by anastomosing with one another and supplying the vastus externus and the hamstring muscles. The second or third gives off the main nutrient artery to the femur.

The obturator nerve, while passing through the upper part of the obturator foramen, breaks up into an anterior and a posterior division. The anterior passes downwards behind the pectineus and adductor longus and in front of the adductor brevis. It supplies these three muscles, the adductor gracilis, a twig to the hip joint, and a small cutaneous branch to the inner aspect of the thigh. The accessory obturator nerve, when present, enters the thigh in front of the ascending ramus of the pubis and after giving twigs to the hip joint and pectineus joins the anterior division. The posterior division of the obturator nerve pierces the upper edge of the obturator externus, and then runs downwards between the adductors brevis and magnus. It innervates these three muscles, while its terminal filament supplies the knee joint.

The quadriceps muscle is composed of the rectus femoris, the vastus externus, the vastus internus and the vastus intermedius. They possess a common insertion into the upper and lateral margins of the patella. They are all supplied by the femoral nerve and their action is to extend the knee. The rectus femoris possesses the additional action of flexing the hip.

The rectus femoris arises from the anterior inferior spine of the ilium and from a special pit just above the upper edge of the acetabulum. The vastus externus takes origin from the anterior and inferior aspects of the root of the great trochanter, from the outer side of the gluteal ridge and from the upper part of the outer lip of the linea aspera. The vastus internus obtains its origin from the spiral line and from the inner lip of the linea aspera. The vastus intermedius arises from the anterior and external aspects of the femur in their upper two thirds.

The articular muscle of the knee is the name given to a few scattered fibres which arise from the anterior surface of the femur in its lower third, and obtain insertion into the suprapatellar protrusion from the synovial membrane of the knee joint. Its nerve supply is from the femoral and its action is to pull up this protrusion during the extension movement of the knee joint.

The femoral nerve enters the thigh behind the inguinal ligament, just external to the femoral artery. It immediately divides into anterior and posterior divisions. The anterior supplies the pectineus and sartorius, and is then continued on as the intermediate and internal cutaneous nerves of the thigh. The posterior division innervates the rectus femoris, the three vasti muscles and the articular muscle of the knee. Its only cutaneous nerve is the long saphenous, which, after traversing the adductor canal, becomes cutaneous on the inner aspect of the knee, where it gives off its patellar twig. It is continued down the inner side of the leg in company with the long saphenous vein and will be studied later on the dorsum of the foot. Certain of the nerves to the quadriceps muscle supply the knee joint while the nerve to the rectus femoris also furnishes an articular twig to the hip joint.

Three septa, which pass from the deep fascia to the linea aspera of the femur, divide the thigh into three muscular compartments. The anterior contains the quadriceps group which is innervated by the femoral nerve, the internal contains the adductors which are supplied by the obturator nerve, while the posterior compartment lodges the three hamstring muscles which obtain their nerve supply from the sciatic.

THE GLUTEAL REGION OR BUTTOCK.

After reflecting the skin the following cutaneous nerves will have to be searched for. Descending over the crest of the ilium will be found the posterior primary divisions of the first three lumbar nerves, the ilio-hypogastric nerve and the iliac branch of the last dorsal nerve.

The posterior primary divisions of the first three sacral nerves may be discovered piercing the sacral origin of the gluteus maximus. Winding round the lower border of the gluteus maximus are one or two twigs from the posterior cutaneous nerve of the thigh.

Upon cleaning the gluteus maximus it will be observed that it is the largest muscle in the body. It arises from the area on the dorsum ilii between the posterior curved line and the crest, from the lower two pieces of the sacrum, the upper three pieces of the coccyx, the sacro-tuberous ligament and slightly from the lumbar fascia. The muscle fibres are directed downwards and outwards and are all inserted into the fascia lata except the deep fibres of the lower half which obtain direct attachment to the gluteal ridge of the femur. Its nerve supply is from the inferior gluteal and its action is to extend the hip and rotate the thigh outwards. Upon reflecting the muscle a bursa will be found intervening between it and the ischial tuberosity, and one between it and the great trochanter. The following muscles will also be exposed, and are named from above downwards—(1) gluteus medius (2) pyriformis (3) The tendon of the obturator internus with the two gemellus muscles (4) The quadratus femoris (5) The upper end of the adductor magnus.

The gluteus medius arises from the area on the dorsum ilii between the posterior and middle curved lines. Its fibres run downwards and outwards to be inserted into the diagonal line on the outer surface of the great trochanter of the femur. Its nerve supply is derived from the superior gluteal and its action is to abduct the thigh and rotate it outwards.

The pyriformis arises inside the pelvis from the second, third and fourth pieces of the sacrum and slightly from the upper edge of the great sciatic foramen through which the muscle emerges. The muscle is directed downwards and outwards to its insertion into the upper border of the great trochanter. Its nerve supply comes from the sacral plexus, and its action is to rotate the thigh outwards.

The obturator internus muscle also takes origin inside the pelvis from the margin of the obturator foramen except above, and from the deep surface of the obturator membrane. Its tendon escapes from the pelvis through the lesser

sciatic foramen, which it grooves deeply. It is inserted into the inner aspect of the great trochanter. Its nerve supply is derived from the sacral plexus and its action is to rotate the thigh outwards. The superior and inferior gemellus muscles arise from the upper and lower margins, respectively, of the lesser sciatic formen and they are inserted into the tendon of the obturator internus. The superior muscle is supplied by the nerve to the obturator internus, and the inferior by the nerve to the quadratus femoris.

The quadratus femoris obtains origin from the outer edge of the ischial tuberosity. Its fibres pass horizontally outwards to be inserted into the posterior border of the great trochanter. Its nerve supply is derived from the sacral plexus, and its action is to adduct the thigh and rotate it outwards.

The following six nerves emerge from the pelvis through the great sciatic foramen below the level of the pyriformis. These are (1) The sciatic (2) The posterior cutaneous nerve of the thigh (3) The inferior gluteal (4) The internal pudendal (5) The nerve to the obturator internus (6) The nerve to the quadratus femoris. They are all branches of the sacral plexus. Two arteries, the inferior gluteal and the internal pudendal, also emerge in the same situation and they are both branches of the internal iliac artery.

The sciatic nerve after emerging from the pelvis through the lower part of the great sciatic foramen below the pyriformis is directed downwards and outwards at first in order to gain a position intermediate between the ischial tuberosity and the great trochanter. From this point its course is vertically downwards to its termination half way down the back of the thigh, where it ends by dividing into the external and internal popliteal nerves. From above downwards it rests upon the ischium, the obturator internus tendon with the two gemelli, the quadratus femoris and the adductor magnus. Superficially it is covered by the gluteus maximus and the biceps. It supplies the three hamstring muscles and the adductor magnus.

The small sciatic or posterior cutaneous nerve of the thigh emerges with the sciatic and accompanies it closely in the gluteal region. It sends off a few cutaneous twigs round the lower edge of the gluteus maximus, and the long pudendal nerve which sweeps inwards over the origin of the hamstring muscles to supply the external genitals. It is then continued down the back of the thigh under the deep fascia which it pierces in the popliteal space. It supplies the skin on the back of the thigh and the upper part of the calf of the leg.

The inferior gluteal nerve innervates the gluteus maximus.

The internal pudendal nerve and the nerve to the obturator internus cross the attachment of the sacro-spinous ligament to the ischial spine in company with the internal pudendal vessels, and thus re-enter the pelvis. They are therefore seen for a very brief period in this dissection, the vessels being intermediate, with the pudendal nerve on their inner side and the nerve to the obturator internus on their outer side.

The nerve to the quadratus femoris will be found lying under cover of the upper end of the sciatic nerve. It courses downwards on the deep aspect of the

gemelli and obturator internus tendon in order to reach its muscle. It also supplies the inferior gemellus.

The inferior gluteal or sciatic artery emerges with the sciatic nerve and runs downwards in close association with it. It gives numerous branches to the gluteus maximus, and sends a few cutaneous twigs round the lower edge of this muscle. It is then continued down the back of the thigh as a cutaneous vessel in company with the posterior cutaneous nerve. It gives off branches to the other muscles of the gluteal region, a nutrient artery to the sciatic nerve and a branch to join the crucial anastomosis. The latter is a very important chain of communication between the internal and external iliac, the femoral and the popliteal arteries by means of the superior and inferior gluteal, the external and internal circumflex, the four perforating arteries, and a branch from the popliteal. The ascending and transverse terminal branches of the internal circumflex artery should now be looked for at the upper and lower borders of the quadratus femoris.

The gluteus medius must now be reflected in order to expose the gluteus minimus and the superior gluteal vessels and nerve.

The gluteus minimus takes origin from the area on the dorsum ilii included between the middle and anterior curved lines. Its fibres run downwards to be inserted into an impression on the anterior border of the great trochanter of the femur. Its nerve supply is derived from the superior gluteal, and its action is to abduct the thigh, and slightly rotate it inwards.

The tensor fasciae femoris is so closely associated with the anterior borders of the gluteus medius and minimus, that its study is essential at this stage. It arises from the outer edge of the iliac crest just behind the anterior superior spine, for about two inches. Its fibres run downwards and slightly backwards to their insertion between two lamellae of the fascia lata. Its nerve supply is from the superior gluteal and its action is to render the fascia lata tense, and rotate the thigh inwards slightly.

The superior gluteal artery is a branch of the internal iliac, and emerges from the pelvis through the great sciatic foramen above the pyriformis. It immediately divides into a superficial branch which supplies the gluteus maximus and a deep branch which passes under cover of the gluteus medius. This also divides into two branches, an upper which follows the middle curved line of the ilium to anastomose with the circumflex iliac and a lower branch which accompanies the superior gluteal nerve under cover of the tensor fasciae femoris, where it anastomoses with the ascending branch of the external circumflex artery.

The superior gluteal nerve is a branch of the sacral plexus, and emerges above the pyriformis along with the superior gluteal artery. It accompanies the deep branch of this artery between the gluteus medius and minimus, freely dispensing twigs to both and finally ending in the tensor fasciae femoris.

THE POPLITEAL SPACE.

It is best to remove the skin from the back of the thigh and from the upper third of the back of the leg, and thus be able to complete the study of the course of

the posterior cutaneous nerve of the thigh which has already been outlined. It will then be necessary to devote attention to the popliteal space, which is the lozenge shaped area situated on the back of the knee region. The deep fascia forming its roof is very dense, and is pierced by the terminal portion of the posterior cutaneous nerve of the thigh, and also by the short saphenous vein. The popliteal space is bounded above and externally by the biceps, above and internally by the semimembranosus and semitendinosus, below and externally by the outer head of the gastrocnemius and the plantaris, and infero-internally by the inner head of the gastrocnemius. Of these muscles the three hamstrings are the only ones than can be fully studied at present, so that it will be necessary to clean these and define their attachments.

The biceps arises by means of its long head from the inner area on the ischial tuberosity in conjunction with the semitendinosus. Its short or femoral head takes origin from the outer lip of the linea aspera and the upper part of the external supracondylar ridge of the femur. Its tendon of insertion into the head of the fibula is split by the external ligament of the knee. A slip from its tendon is also inserted into the deep fascia of the leg. Its nerve supply is from the sciatic, and its chief actions are to extend the hip and flex the knee.

The semitendinosus has been already shown to possess an origin common to it and the long head of the biceps. The muscle is directed downwards upon the superficial surface of the semi membranosus to the level of the knee, below which it curves forwards to be inserted into the internal surface of the tibia, behind the sartorius and below the gracilis. Its nerve supply and chief actions are the same as those of the biceps.

The semimembranosus obtains origin from the outer area on the ischial tuberosity by a long tendon shaped like a razor-blade. It is directed downwards on the deep aspect of the biceps-semitendinosus origin, and is inserted into a groove on the postero internal aspect of the upper end of the tibia, and in addition sends slips to the posterior and internal ligaments of the knee, to the fascia of the popliteus muscle and to the deep fascia of the leg. Its nerve supply and chief actions are the same as those of the biceps.

On opening up the popliteal space and removing the adipose tissue, it will be ascertained that the contents are—(1) The popliteal artery and its branches (2) The popliteal vein and its tributaries, including the short saphenous vein (3) The internal and external popliteal nerves and their branches (4) The genicular branch of the obturator nerve (5) Lymph glands and vessels. The floor of the space will then be found to be formed from above downwards by the popliteal surface of the femur, the posterior ligament of the knee joint, and the fascia covering the popliteus muscle.

The popliteal artery begins at the opening in the adductor magnus as a continuation of the femoral. It is at first directed downwards and outwards, in order to gain the interval between the two condyles of the femur, after which it runs vertically downwards. It ends at the lower border of the popliteus muscle by dividing into anterior and posterior tibial arteries. From above downwards it rests upon the floor of the popliteal space, being separated, however, from the

femur by a layer of fat. The popliteal vein is to its outer side above, lies directly superficial to it in the middle of the space, and comes to lie to its inner side below. The internal popliteal nerve is external to both artery and vein above, lies directly superficial to them in the middle of the space and comes to lie to their inner side below. The branches of the popliteal artery are—(1) Five genicular arteries (2) muscular (3) cutaneous.

The genicular arteries are recognised by the fact that they lie upon the floor of the popliteal space. The superior external arches outwards under the biceps, the superior internal arches inwards under the semimembranosus and semitendinosus, the inferior external passes outwards under the plantaris and outer head of the gastrocnemius, and the inferior internal runs downwards and inwards under the inner head of the gastrocnemius. These four arteries join the patellar anastomosis, which will be studied later. The fifth or azygos genicular artery is readily recognised from the fact that it pierces the posterior ligament of the knee.

The muscular branches of the popliteal artery are arranged in upper and lower sets. Those of the upper group supply the hamstring muscles and one of these completes the crucial anastomosis. The lower muscular branches supply the calf muscles and are therefore termed sural.

The cutaneous branches supply the skin over the calf and are therefore termed superficial sural.

The popliteal vein begins at the lower border of the popliteus muscle by the union of the venae comites of the anterior and posterior tibial arteries. At first it is to the inner side of the artery, in the middle of the space it lies directly superficial, and at the opening in the adductor magnus it is placed to the outer side of the artery. Here it becomes continuous with the femoral vein. Its tributaries correspond to the branches of the artery and in addition it receives the short saphenous vein.

The internal popliteal nerve is the larger terminal branch of the sciatic, and commences about the middle of the back of the thigh. It enters the popliteal space at the upper angle and disappears between the two heads of the gastrocnemius inferiorly, so that it bisects the space vertically. Above, it lies to the outer side of the popliteal vessels, in the middle of the space it lies directly superficial to these, and below, it is placed to their inner side. At the lower border of the popliteus muscle it changes name into posterior tibial. Its branches are—(1) genicular (2) muscular (3) communicating.

The three genicular branches accompany the superior internal, inferior internal and azygos genicular arteries to the knee joint. The muscular branches supply the gastrocnemius, plantaris, soleus and popliteus. The communicating branch joins the corresponding branch from the external to form the short saphenous nerve in the lower part of the back of the leg.

The external popliteal nerve has the same point and mode of origin as the internal. It takes its course from the tendon of the biceps, which it follows closely down to its insertion. The nerve then passes forwards on the neck of the fibula under cover of the peroneus longus, where it ends by dividing into the anterior

tibial and musculo-cutaneous nerves. Its branches are (1) genicular (2) communicating (3) cutaneous. The three genicular branches accompany the superior and inferior external genicular and the anterior tibial recurrent arteries into the knee joint. The communicating branch unites with the corresponding branch from the internal popliteal as already noted. The cutaneous twig supplies the skin on the outer aspect of the leg.

The genicular branch of the obturator nerve runs downwards in the popliteal space to the inner side of the artery and pierces the posterior ligament of the knee joint.

THE FRONT OF THE LEG AND DORSUM OF THE FOOT.

Reflect the skin from the front of the leg and the dorsum of the foot. The long saphenous nerve and vein will be found running down the inner side of the leg and both pass in front of the internal malleolus. The nerve ends a short distance beyond this while the vein will be seen to drain the inner end of a venous arch on the dorsum of the foot, the outer end being drained by the short saphenous vein which passes up the leg behind the external malleolus. In the lower third of the leg the musculo-cutaneous nerve becomes cutaneous and when traced downwards divides into inner and outer branches. The inner division supplies the inner side of the great toe and the adjacent margins of the second and third toes, while the outer furnishes two branches to supply the adjacent margins of the third, fourth and fifth toes. The terminal portion of the anterior tibial nerve supplies the adjacent margins of the great and second toes. The short saphenous nerve reaches the foot behind the external malleolus in company with the corresponding vein and ends by supplying the outer border of the foot and the outer side of the little toe.

On removing the superficial fascia it will be observed that the deep fascia is much thickened especially in the bend of the ankle where it forms the upper and lower anterior annular ligaments. The upper extends between the anterior borders of the tibia and fibula just above the malleoli, and contains only one special compartment, namely for the tibialis anterior. The lower anterior annular ligament is Y shaped and is attached by its stem to the fore end of the calcaneus. When traced inwards its upper limb passes to the internal malleolus, while the lower sweeps inwards over the inner border of the foot to blend with the plantar fascia. This ligament possesses three compartments of which the inner most transmits the tibialis anterior tendon, the middle one the extensor longus hallucis tendon and the outermost one the tendons of the extensor longus digitorum and peroneus tertius. The anterior tibial vessels and nerve pass under the ligament between the middle and outermost compartments.

There are four muscles in the front of the leg—the tibialis anterior, the extensor longus digitorum, the extensor longus hallucis and the peroneus tertius.

The tibialis anterior arises from the upper two thirds of the external surface of the tibia, from the deep fascia, interosseous membrance, and the intermuscular

septa. Its tendon passes under the anterior annular ligaments and then sweeps round the inner border of the foot to gain its insertion into the inner aspects of the internal cuneiform bone and the base of the first metatarsal bone. Its nerve supply is derived from the anterior tibial, and its action is to flex the ankle, and invert the foot at the mid tarsal joint.

The extensor longus digitorum arises from the external tuberosity of the tibia, the head and upper three fourths of the extensor surface of the fibula, and also from the interosseous membrane, the deep fascia, and septa. Its tendon passes under the two anterior annular ligaments and divides into four on the dorsum of the foot. These pass to the four outer toes where each divides into three slips opposite the proximal inter phalangeal joint. The middle slip is inserted into the base of the second phalanx, while the lateral slips unite at their insertion into the distal phalanx. Thus the arrangement of the tendons of this muscle is exactly similar to that exhibited by the extensor communis digitorum of the hand. The nerve supply of the extensor longus digitorum is derived from the anterior tibial, and its action is to flex the ankle and extend the four outer toes.

The extensor longus hallucis arises from the middle two fourths of the extensor surface of the fibula to the inner side of the extensor longusdigitorum, and also from the interosseous membrane and septa. Its tendon passes forwards on the dorsum of the foot to obtain insertion into the distal phalanx of the great toe. Its nerve supply is from the anterior tibial, and its action is to flex the ankle and extend the great toe.

The peroneous tertius arises from the lower fourth of the extensor surface of the fibula immediately below the extensor longus digitorum, with the fibres of which it is directly continuous. Its tendon after passing under the anterior annular ligaments diverges towards the outer border of the foot to obtain insertion into the base of the fifth metatarsal bone on its dorsal aspect. Its nerve supply is from the anterior tibial, and its action is to flex the ankle, and evert the foot at the mid-tarsal joint.

The extensor brevis digitorum will be observed resting on the dorsum of the foot. It takes origin from the fore end of the calcaneus, and its four tendons pass forwards obliquely over the dorsum of the foot. The innermost is inserted into the base of the proximal phalanx of the great toe, while the other three blend with the tendons of the extensor longus digitorum to the second, third and fourth toes. Its nerve supply is from the anterior tibial and its action is to extend the four inner toes.

The anterior tibial artery is the smaller terminal branch of the popliteal, and begins at the lower border of the popliteus muscle. At first it is directed forwards through the upper part of the interosseous membrane and then runs vertically downwards upon this. In the lower third of the leg it inclines inwards slightly, and comes to rest upon the lower part of the tibia. In front of the ankle joint at a point midway between the two malleoli it passes on to the dorsum of the foot and changes name into dorsalis pedis. Superficially it is overlapped from the inside by the tibialis anterior, and from the outside by the extensors of the toes. It is

accompanied by two venae comites. The anterior tibial nerve lies to its outer side in the upper third of the leg, directly anterior in the middle third, and again to its outer side in the lower third.

The branches are—

(1) The two tibial recurrent,
(2) Muscular,
(3) The two malleolar,

The posterior tibial recurrent arises from the horizontal portion and passes upwards under cover of the popliteus in order to enter the knee joint through the posterior ligament. The anterior tibial recurrent arises immediately after the main artery pierces the interosseous membrane. It runs upwards in the substance of the tibialis anterior to join the patellar anastomosis. The anterior tibial gives off its muscular branches throughout its whole course. The external and internal malleolar are so called because each passes over the corresponding malleolus. They supply the subcutaneous tissues in their vicinity and the external, in addition, anastomoses with the tarsal and peroneal arteries.

The patellar anastomosis should be fully studied at this stage, as the six arteries entering into its composition have now been mentioned. These six arteries approach one another from opposite margins of the limb and anastomose. The superior external genicular meets the anastomotic just above the patella, while the inferior external genicular and the anterior tibial recurrent meet, respectively, the superior internal genicular and the inferior internal genicular under cover of the ligamentum patellae.

The dorsalis pedis artery begins in front of the ankle joint at a point midway between the two malleoli as a continuation of the anterior tibial. It runs forwards upon the astragalus, navicular and middle cuneiform bones to reach the interval between the bases of the first and second metatarsal bones, through which it passes into the sole of the foot to end by joining the plantar arch. It is covered superficially by the skin and fasciae, and is also crossed by the innermost tendon of the extensor brevis digitorum. The artery lies between the tendon of the extensor longus hallucis and the innermost tendon of the extensor longus digitorum. It is accompanied by two venae comites and the anterior tibial nerve lies on its outer side.

Its branches are—

(1) Tarsal
(2) Metatarsal
(3) Dorsalis Hallucis
(4) Magna Hallucis

The tarsal artery passes outwards over the tarsal bones and under cover of the extensors. It supplies the tissues in its vicinity and ends by anastomosing on the outer border of the foot with the external malleolar, peroneal and metatarsal arteries. The metatarsal artery runs outwards upon the bases of the metatarsal bones and under cover of the extensor tendons. It gives off three dorsal interosseous arteries which run forwards to supply the outer three and one

half toes. The dorsalis hallucis branch of the dorsalis pedis comes off just as the artery is disappearing through the first space. It runs forwards to supply the inner side of the great toe and the adjacent margins of the great and second toes—one and a half toes in all. The magna hallucis branch will be studied later in the sole of the foot. It supplies the inner one and a half toes upon their plantar aspects.

The anterior tibial nerve is the larger terminal branch of the external popliteal and at its origin rests on the neck of the fibula under cover of the peroneus longus. It pierces the extensor longus digitorum obliquely and comes to lie on the outer side of the anterior tibial vessels. In the middle third of the leg it lies directly in front of these, but in the lower third again lies external. On the dorsum of the foot it is continued forwards on the outer side of the dorsalis pedis vessels and ends by dividing to supply the adjacent margins of the great and second toes It innervates the tibialis anterior, the extensor longus digitorum the extensor longus hallucis, the peroneus tertius and the extensor brevis digitorum. It likewise gives twigs to certain of the tarsal and metatarsal joints of the foot.

THE PERONEAL REGION OF THE LEG.

The peroneus longus and peroneus brevis muscles will be found lying on the outer aspect of the leg. These should be cleaned and the musculo-cutaneous nerve which lies between them exposed.

The peroneus longus arises from the head and upper two thirds of the external surface of the shaft of the fibula and from the fascia. Its tendon curves forwards round the external malleolus, and then enters the groove on the under aspect of the cuboid in order to reach the sole of the foot, where it is inserted into the plantar aspect of the internal cuneiform and the base of the first metatarsal. It is supplied by the musculo-cutaneous, and its action is to extend the ankle, and evert the foot at the midtarsal joint.

The peroneus brevis arises from the lower two thirds of the external surface of the fibula, its upper end being in front of the peroneus longus. Its tendon sweeps round the external malleolus, and then passes forwards on the outer border of the foot to its insertion into the base of the fifth metatarsal bone. Its nerve supply and its action are the same as those of the peroneus longus.

These two tendons are held in place behind the external malleolus by the external annular ligament which passes from the posterior border of this downwards and backwards to be attached to the outer aspect of the calcaneus. Under this ligament there is a common synovial sheath which sends an extension along each tendon. The peroneal tubercle of the calcaneus intervenes between these extensions.

The musculo-cutaneous nerve begins on the neck of the fibula under cover of the peroneus longus as the smaller terminal branch of the external popliteal. It courses downwards between the peroneus longus and brevis, supplying both; and becomes cutaneous by piercing the deep fascia in the lower third of the front of the leg. This part of its distribution has been already studied.

THE POSTERIOR ASPECT OF THE LEG.

After reflecting the skin from the back of the leg one will be able to trace the communicating nerves from the external and internal popliteal to their union in the lower third of the leg to form the short saphenous. The dissector will also be in a position to study the complete course of the short saphenous vein. The deep fascia may then be removed in order to expose the calf muscles which are three in number, namely, the gastrocnemius, plantaris and soleus.

The gastrocnemius arises by its inner head from the posterior aspect of the femur just above the internal condyle. The outer head has a corresponding relation to the external condyle; but is slightly higher and more external in order to make room for the plantaris origin. The two muscular bellies remain distinct, and it will be noted that the internal descends to a slightly lower level than the external. The flattened tendon of insertion blends with that of the soleus to form the tendo achillis which is inserted into the transverse ridge on the tuberosity of the calcaneus. Its nerve supply is from the internal popliteal, and its action is to flex the knee and raise the body on tip toe.

The plantaris is atrophic in man. It arises under cover of the outer head of the gastrocnemius immediately above the external condyle of the femur. Its tendon blends with the tendo achillis, or may be inserted independently into the inner edge of the calcaneal tuberosity, or even into the plantar fascia. Its nerve supply and action are the same as those of the gastrocnemius.

The tendon of the gastrocnemius may be divided just above its line of blending with the soleus in order to expose the latter muscle, which will be seen to arise from the posterior aspects of the head and upper third of the shaft of the fibula, from the oblique line of the tibia, and also from the inner edge of the tibia for about two inches. Its tendon forms the greater part of the tendo achillis. The nerve supply is from the internal popliteal and its action is to raise the body on tip toe. Note the bursa between the tendo achillis and the calcaneus.

On reflecting the soleus from the oblique line and inner border of the tibia a good view will be obtained of the posterior tibial vessels and nerve and the four deep muscles which are the popliteus, the flexor longus digitorum, the flexor longus hallucis and the tibialis posterior.

The popliteus arises within the capsule of the knee joint from a special pit on the outer aspect of the external condyle of the femur. The muscle spreads out into a fleshy insertion which occupies the area on the posterior aspect of the tibia above the oblique line. Its nerve supply is from the internal popliteal, and its action is to flex and rotate the knee joint.

The flexor longus digitorum arises from the inner half of the posterior surface of the tibia below the oblique line and from the septa. Its tendons will be studied later in the sole of the foot. They are inserted into the distal phalanges of the four outer toes. This muscle is thus the homologue of the flexor profundus digitorum. Its nerve supply is from the posterior tibial, and its action is to extend the ankle and flex the four outer toes.

The flexor longus hallucis arises from the lower two-thirds of the posterior surface of the fibula and from the septa. Its tendon is inserted into the distal phalanx of the great toe. It is innervated by the posterior tibial and its action is to extend the ankle and flex the great toe.

The tibialis posterior arises from the outer half of the posterior surface of the tibia below the oblique line, from a special elongated area on the fibula immediately behind its interosseous border, and from the septa and the interosseous membrane. Its tendon is inserted chiefly into the tubercle of the navicular, but it also sends slips to all the other bones of the tarsus except the astragalus, and to the bases of the second, third and fourth metatarsals. Its nerve supply is derived from the posterior tibial and its action is to extend the ankle and invert the foot at the midtarsal joint.

The internal annular ligament is a thickened band of deep fascia which passes from the posterior border of the internal malleolus downwards and backwards to the tuberosity of the calcaneus. There are three compartments for tendons:

(1) The innermost transmits the tibialis posterior,
(2) The intermediate contains the flexor longus digitorum,
(3) The outermost the flexor longus hallucis,
(4) The posterior tibial vessels and nerve pass under the ligament between the intermediate and the outermost compartments, the nerve lying next to the flexor longus hallucis.

The posterior tibial artery is the larger terminal branch of the popliteal and begins at the lower border of the popliteus muscle. It runs downwards on the back of the leg with a slight inclination inwards and ends midway between the internal malleolus and the tuberosity of the calcaneus, under cover of the internal annular ligament, by dividing into the internal and external plantar arteries. It rests from above downwards upon the tibialis posterior, the tibia and the posterior ligament of the ankle joint. Superficially it is covered in the upper two-thirds of the leg by the calf muscles, and in the lower third by the skin, superficial and deep fasciae including the internal annular ligament. It is accompanied by two venae comites. The posterior tibial nerve is at first to its inner side, crosses it superficially in the middle third of the leg and then lies to its outer side in the lower third.

Its branches are—

(1) nutrient,
(2) peroneal,
(3) muscular,
(4) communicating,
(5) calcanean,
(6) terminal branches.

The nutrient artery comes off close to the origin and is directed downwards to enter the nutrient foramen of the tibia. It is the largest nutrient artery in the body.

The peroneal artery arises one inch below the origin of the posterior tibial and is directed downwards under cover of the fibular origin of the flexor longus hallucis. Just above the ankle it divides into anterior and posterior terminal branches, of which the anterior pierces the interosseous membrane to gain the anterior aspect of the external malleolus, while the posterior is continued downwards behind this. They anastomose with the external malleolar and tarsal arteries. In addition to muscular branches and the nutrient artery to the fibula the peroneal also gives off a communicating branch which anastomoses on the back of the tibia with the corresponding branch from the posterior tibial.

The calcanean branch of the posterior tibial artery pierces the internal annular ligament close to the calcaneus and supplies the soft tissues over the heel.

The posterior tibial nerve begins at the lower border of the popliteus muscle as a continuation of the internal popliteal. At first on the inner side of the artery, it crosses this superficially in the middle of the leg and thus comes to lie on its outer side. At the same point as the artery it ends by dividing into external and internal plantar nerves. It supplies the tibialis posterior, the flexor longus digitorum, and the flexor longus hallucis. It also gives a twig to the ankle joint and a calcanean nerve which accompanies the artery of the same name to supply the skin of the heel.

THE SOLE OF THE FOOT.

After reflecting the skin it is best to make a longitudinal incision through the dense, tough, superficial fascia, and dissect this off outwards and inwards from the glistening central portion of the plantar fascia, on each side of which the cutaneous nerves and vessels will be discovered. These come from the plantar nerves and vessels. On removing the remainder of the superficial fascia, it will be observed that the plantar fascia consists of a strongly developed central portion flanked by thinner external and internal portions.

The central portion of the plantar fascia is attached posteriorly to the internal tubercle of the calcaneus. When traced forwards it divides into five slips, each of which splits into two. These blend with the sheaths of the flexor tendons, as in the case of the hand.

The plantar fascia may now be reflected forwards, when it will be observed that the central portion clothes the flexor brevis digitorum while the external and internal portions invest the abductor minimi digiti and the abductor hallucis respectively. These three muscles constitute the first layer of the sole.

The abductor hallucis arises from the internal tubercle of the calcaneus, from the plantar fascia and from the internal annular ligament. Its tendon is inserted into the inner aspect of the base of the proximal phalanx of the great toe. It is innervated by the internal plantar, and its action is to abduct the great toe.

The flexor brevis digitorum takes origin from the internal tubercle of the calcaneus and from the plantar fascia. Each of its four tendons is split by the long flexor tendon, as in the hand. They are inserted into the margins of the second phalanges of the four outer toes. This muscle is thus the homologue of the flexor sublimis digitorum. Its nerve supply is derived from the internal plantar, and its action is to flex the two proximal joints of the four outer toes.

The abductor minimi digiti arises from the internal and external tubercles of the calcaneus and from the plantar fascia. Its tendon is inserted into the outer side of the base of the proximal phalanx of the little toe. It is supplied by the external plantar nerve, and its action is to abduct the little toe.

On reflecting these three muscles forwards from their origins, the plantar vessels and nerves will be exposed, as also the second layer of the sole which consists of the long flexor tendons, the accessorius muscle and the lumbrical muscles which take origin from the tendons of the flexor longus digitorum. The first lumbrical arises from the inner side of the first tendon, while the second, third and fourth take origin from the tendons between which they lie. The lumbrical muscles sweep round the inner sides of the four outer toes to gain insertion into the extensor tendons. The first is supplied by the internal plantar nerve, the others by the external plantar.

The accessorius muscle arises by its two heads from the inner and outer aspects of the calcaneus, and is inserted into the tendon of the flexor longus digitorum at its point of splitting. It is innervated by the external plantar nerve, and its action is to pull the long flexor tendons into line with the toes upon which they act.

The accessorius must now be reflected from its origins and the two long flexor tendons cut far back in order to expose the muscles of the third layer of the sole. On turning these forwards it will be observed that the tendon of the flexor longus hallucis gives a strong slip to the tendon of the flexor longus digitorum.

The four muscles of the third layer are arranged to form three sides of a square and one diagonal. They are—the flexor brevis hallucis, the flexor brevis minimi digiti, the adductor transversus hallucis and the adductor obliquus hallucis.

The flexor brevis hallucis arises from the tendinous slips of the tibialis posterior. It divides into two parts at its insertion which is into both sides of the base of the proximal phalanx of the great toe. Its nerve supply is from the internal plantar and its action is to flex the great toe.

The flexor brevis minimi digiti arises from the plantar aspect of the base of the fifth metatarsal bone and from the sheath of the peroneus longus tendon. It is inserted into the outer aspect of the base of the proximal phalanx of the little toe. Its nerve supply is derived from the external plantar and its action is to flex the little toe.

The adductor transversus hallucis arises from the capsules of the metatarso phalangeal joints of the three outer toes, and is inserted into the outer aspect of the base of the proximal phalanx of the great toe. It is innervated by the external plantar and its action is to adduct the great toe.

The adductor obliquus takes origin from the plantar aspects of the bases of the second, third and fourth metatarsal bones and from the sheath of the peroneus longus tendon. It passes diagonally to obtain insertion with the transverse adductor. Its nerve supply and action are the same as those of the preceding. On reflecting this muscle the plantar arterial arch will be exposed.

The external plantar artery is the larger terminal branch of the posterior tibial. From its point of origin midway between the internal malleolus and the calcanean tuberosity it proceeds at first outwards between the flexor brevis digitorum and the accessorius, and then forwards between the flexor brevis digitorum and the abductor minimi digiti. Opposite the base of the fifth metatarsal bone it curves inwards upon the bases of the metatarsal bones, and under cover of the adductor obliquus hallucis, to reach the first space where it joins with the dorsalis pedis to form the plantar arch. The artery is accompanied by the external plantar nerve. The external plantar artery supplies cutaneous twigs to the skin of the heel and sole, and a few muscular branches; while the plantar arch gives off;

(1) four digital arteries to supply the outer three and one half toes,
(2) three perforating arteries which pass upwards through the outer three spaces to join the dorsal interosseous arteries,
(3) two or three recurrent twigs to the tarsal joints.

The internal plantar artery passes forwards into the sole of the foot between the abductor hallucis and the flexor brevis digitorum. After supplying cutaneous twigs to the skin of the sole and a few muscular branches, it ends in ill defined digital twigs to the inner toes.

The magna hallucis artery which springs from the dorsalis pedis in the first intermetatarsal space should now be secured. It passes forwards and divides into two branches which supply the inner side of the great toe and the adjacent margins of the great and second toes. It thus supplies one and a half toes.

The external plantar nerve is the smaller terminal branch of the posterior tibial, and arises at the same point as the artery, which it accompanies in the sole of the foot. The trunk supplies cutaneous twigs to the sole of the foot and muscular branches to the abductor minimi digiti and the accessorius. It then divides into superficial and deep branches, of which the former supplies the flexor brevis minimi digiti and the outermost interosseous muscles and then terminates by supplying the outer side of the little toe and the adjacent margins of the fourth and fifth toes. The deep branch supplies the two adductors of the great toe, the outer three lumbricals and the interossei.

The internal plantar nerve accompanies the artery, and from its trunk supplies cutaneous twigs to the sole and muscular branches to the abductor hallucis and the flexor brevis digitorum. It then divides into four digital branches which supply the inner side of the great toe and the adjacent margins of the great and second, second and third, and third and fourth toes. The first digital branch supplies also the flexor brevis hallucis, while the second innervates the first lum-

brical muscle. It will be noted that the internal plantar nerve supplies the inner three and one half toes.

The interosseous muscles constitute the fourth layer of muscles in the sole of the foot.

The interosseous muscles are seven in number—four dorsal and three plantar The dorsal interossei abduct the toes from an imaginary line drawn through the second toe. They arise from the metatarsal bones between which they lie. The first and second are inserted on each side of the second toe, the third on the outer side of the third toe and the fourth on the outer side of the fourth toe. Their insertions are partly into the bases of the proximal phalanges and partly into the extensor tendons.

Each plantar interosseous arises from the metatarsal bone of the toe upon which it acts. The first is inserted upon the inner side of the third toe, the second upon the inner side of the fourth toe, and the third upon the inner side of the fifth toe.

The time is now opportune for the completion of the study of the tendons of the tibialis posterior and peroneus longus, in order to ascertain their exact mode of insertion.

Note that, just as in the hand, the skin on the dorsal aspect of the distal phalanx of every digit, including the bed of the nail, is supplied by blood vessels and nerves from the plantar aspect of the foot. Therefore the cutaneous vessels and nerves on the dorsal aspect of each digit do not usually cross the line of the distal joint.

THE THORAX.

DISSECTION.—The remains of the pectoral muscles, the serratus, the latissimus dorsi and the abdominal muscles will require to be removed in order to expose the external and internal intercostal muscles which occupy the intercostal spaces.

The external intercostal muscle takes origin from the lower border of one rib, and its fibres which are directed downwards and forwards, obtain insertion into the upper border of the rib below. Its innervation is from the intercostal nerve. It is a muscle of inspiration. It will be observed that the fibres end anteriorly at the junctions of the ribs with their cartilages, the gaps between these and the sternum being filled in by the anterior intercostal membranes, through which the fibres of the internal intercostal muscles can be seen. Posteriorly the external intercostal muscle extends as far as the tubercles of the ribs. Remove this muscle and the membrane in order to expose the internal intercostal muscle.

The internal intercostal muscle extends as far as the sternum anteriorly, but reaches only as far back as the angle of the rib, the gap between this and the head of the rib being occupied by the posterior intercostal membrane. The

fibres of this muscle are directed downwards and backwards. They take origin above from the upper margin of the subcostal groove and are inserted inferiorly on the deep aspect of the rib, close to its upper border. Some of the fibres cross two spaces and are known as the subcostal muscles. The internal intercostal muscle is innervated by the intercostal nerve. Its action is mainly expiratory, though the inter-chondral fibres are probably inspiratory. On removing this muscle the parietal pleura will be exposed. The intercostal vessels and nerve can then be pulled downwards from the shelter of the subcostal groove. At the same time remove the costal cartilages in order to expose the internal mammary vessels, and the triangularis sterni muscle, which is represented by a few scanty fibres passing from the sternum to the costal cartilages.

The intercostal nerve runs forwards between the intercostal muscles in the subcostal groove along with the vessels the order from above downwards being vein, artery, nerve. Half way towards the front it gives off its lateral cutaneous branch which divides into anterior and posterior twigs to supply the skin on the lateral aspect of the body. The intercostal nerve then gradually sinks into the substance of the internal intercostal muscle and comes to lie between this and the parietal pleura. After passing in front of the internal mammary artery it pierces the intercostal space and the pectoralis major by the side of the sternum, finally ending in the skin over the front of the chest as the anterior cutaneous nerve. It also supplies the intercostal muscles, the triangularis sterni and a few twigs to the pleura.

The intercostal arteries for the upper two spaces come from the subclavian, and those for the lower nine spaces from the aorta. Each artery runs forwards between the external and internal intercostal muscles in the subcostal groove, where it is intermediate in position to the vein and nerve. Half way towards the front it sends off a cutaneous branch to accompany the lateral cutaneous nerve, and then divides into upper and lower branches which run along the margins of the ribs to anastomose with the anterior intercostal arteries.

The internal mammary artery is a branch of the subclavian and enters the thorax behind the first costal cartilage. It courses downwards behind the costal cartilages and intercostal spaces half an inch from the edge of the sternum, and ends in the sixth space by dividing into the superior epigastric and musculo-phrenic arteries. Posteriorly it rests upon the pleura, but is separated partially from this by the triangularis sterni in the lower part of its course. It is accompanied by venae comites. The upper intercostal nerves pass in front of it. The other branches are

(1) A pair of anterior intercostal arteries to each of the upper six spaces,

(2) A perforating cutaneous branch to each of the upper six spaces, which accompanies the anterior cutaneous nerve to supply the skin of the chest and also the inner third of the mamma in the female,

(3) Branches to the mediastinum and to the remains of the thymus gland,

(4) A small artery which accompanies the phrenic nerve to the diaphragm.

The superior epigastric artery enters the rectus sheath behind the seventh costal cartilage, and after supplying the rectus abdominis, ends by anastomosing with the deep epigastric.

The musculo-phrenic artery runs downwards and outwards along the costal attachments of the diaphragm, which it supplies. In addition it furnishes anterior intercostal arteries to the seventh, eighth and ninth spaces. The tenth and eleventh intercostal spaces possess no anterior intercostal arteries.

THE PLEURA AND LUNGS.

Cut away the ribs, from the second to the ninth, just in front of their angles with bone pliers, in order to expose the parietal pleura, which must then be incised crosswise so as to explore the pleural cavity. It will then be observed that the pleura, like all serous membrances, is a closed sac which invests the lung. The space between the right and left pleural sacs is termed the mediastinum, and contains the heart with its great vessels and many other structures.

The layer of pleura that invests the lung substance itself is an intimate part of it, and is termed the visceral pleura. At the root of the lung it becomes continuous with the parietal pleura, so called because it lines the wall of the chest. The portion of this that lines the ribs and intercostal spaces is termed the costal pleura, the part that extends upwards into the root of the neck is known as the cervical pleura, the layer that covers the upper surface of the diaphragm is aptly termed the diaphragmatic portion while the part that is in relation to the mediastinum is known as the mediastinal pleura. It will be noted that the dome of the cervical pleura projects upwards one and a half inches above the level of the anterior end of the first rib, or one inch above the inner third of the clavicle. A special layer of fascia which is attached to the inner edge of the first rib protects this dome superiorly. The right and left pleural sacs when traced downwards, meet in the middle line behind the junction of the manubrium with the body of the sternum. The two remain in contact as far as the fourth costal cartilages, at which level the left pleural sac diverges to the left, owing to the close approximation of the heart to the anterior chest wall. The right pleural sac, however, is continued downwards behind the sternum as far as the level of the sixth or seventh costal cartilage. Both pleural sacs diverge outwards on the upper surface of the diaphragm, their lowest limits in the mammary lines being at the eighth ribs, and in the mid-axillary lines at the tenth ribs. Both pleural sacs extend half an inch below the inner ends of the twelfth ribs by the sides of the vertebral column which they reach at the level of the twelfth dorsal vertebra.

On attempting to push the finger backwards below the level of the root of the lung, it will be found that progress is arrested by the presence of two opposed layers of pleura which extend downwards from the under aspect of the root of the lung to the diaphragm, forming the broad ligament of the lung.

DISSECTION —Further progress is facilitated by removing the lungs, which will be no light task in dissecting room subjects owing to the presence of numerous pleural adhesions. The demonstrator should sever the root of the lung close to the inner surface of the viscus and then cut through the remains of the broad ligament of the lung.

Each lung is cone shaped with a deep indentation, especially in the case of the left, on its inner surface, caused mainly by the heart and the great vessels. The lung therefore presents for examination an apex, a base, external and internal surfaces, and anterior and posterior borders.

The apex extends upwards in the root of the neck to the same level as the cervical dome of the pleura, with which it is in intimate contact. It presents anteriorly a well marked curving groove produced by the subclavian artery, from which, however, it is separated by the cervical pleura and the special layer of fascia previously mentioned.

The base of the lung is concave and is in contact with the corresponding cupola of the diaphragm. It is limited by a sharp margin which does not extend downwards so far as the pleura, since it only reaches the eighth rib in the mid-axillary line and the tenth dorsal vertebra at the back. The base of the right lung is more concave than that of the left owing to the greater convexity of the right cupola of the diaphragm on which it rests.

The outer surface of the lung is strongly convex and is marked by alternate grooves and ridges corresponding to the ribs and intercostal spaces respectively. The outer surface of both lungs is traversed by the great oblique fissure which begins on the posterior border about three inches below the apex and ends below on the sharp margin of the base a little external to the anterior border. In addition, the outer surface of the right lung exhibits the horizontal fissure which begins on its anterior border at the level of the fourth costal cartilage, and is directed outwards horizontally until it reaches the oblique fissure.

The inner surface of the lung is concave, more so in the left lung owing to the greater projection of the heart to the left of the middle line of the body. It exhibits the root of the lung which is rather nearer the base than the apex, and just in front of the posterior border.

In the right lung the vertical groove in front of the root lodges the superior vena cava, while the arching groove above the root is produced by the vena azygos major. The lower portion of the inner surface of the right lung is in contact with the right auricle of the heart An additional feature is a small area below the apex which is in relation to the trachea.

The inner surface of the left lung is in contact for the most part with the left ventricle of the heart. The well pronounced arching groove above the root lodges the arch of the aorta, and from this the groove for the left subclavian artery will be observed to extend upwards over the apex.

The anterior border of the right lung is sharp and vertical in direction throughout, but in the case of the left lung exhibits a deficiency towards its

lower end termed the cardiac notch, which is due to the intimate contact of the heart and pericardium with the anterior chest wall in that region.

The posterior border is rounded and massive and is in contact with the sides of the vertebrae. In addition, it presents a vertical groove which in the right lung lodges the oesophagus, and in the case of the left is occupied by the descending thoracic aorta.

It will be observed from the foregoing paragraphs that the various portions of the lungs, with the exception of the apices, exhibit certain differences on the two sides of the body.

In addition it should be noted that the right lung is the heavier of the two in the proportion of 11 to 10.

The root of each lung contains the bronchus, the pulmonary artery, the two pulmonary veins, bronchial vessels, pulmonary nerves, lymphatic vessels and the bronchial lymph glands. These are firmly bound together by areolar tissue. It will be observed that of the two pulmonary veins one is the most anterior structure in the root, while the other is the most inferior. Just behind the upper vein is the pulmonary artery, and behind this again is the bronchus. The order of the main structures from before backwards is thus, vein, artery, bronchus.

In front of the root of each lung is the anterior pulmonary plexus of nerves, while posteriorly the corresponding vagus nerve trunk breaks up to form the posterior pulmonary plexus. Attached to the under aspect of the root of each lung is the broad ligament of the lung. The right and left phrenic nerves proceed downwards between the mediastinal pleura and the pericardium a short distance in front of the root of the corresponding lung, and may thus be regarded as anterior relations.

In addition to these structures there are relationships special to the root of each lung. For example, the superior vena cava passes downwards in front of the root of the right lung, while the vena azygos major arches forwards over the top of it. Moreover, the aortic arch is an important superior relation of the root of the left lung, and the descending thoracic aorta lies directly posterior to it.

THE MEDIASTINUM.

DISSECTION.—Saw through the manubrium and remove the lower part of the sternum: On gently separating the right and left pleural membranes, one will thereby gain an impression of the existence of the mediastinum which, as previously mentioned, is the space between the right and left pleural sacs. After removing some loose fatty tissue, including the atrophied remains of the thymus gland, the most important content of the space will be exposed in the shape of the heart enclosed in its pericardial sac. Remove the mediastinal pleura on each side of this, taking care meanwhile to secure the right and left phrenic nerves.

The mediastinum contains so many important structures with significant relationships that it is necessary to subdivide it into four portions. An imaginary

plane which passes from the lower border of the manubrium to the lower border of the fourth dorsal vertebra, is utilised to map off the superior from the inferior mediastinum. This plane is rather remarkable for it is practically horizontal. Moreover it passes through the bifurcation of the trachea, and it cuts off the ascending aorta and the descending thoracic aorta from the aortic arch, which thus lies in the superior mediastinum. The inferior mediastinum is conveniently divided into the anterior, middle and posterior mediastina by the pericardium.

The superior mediastinum is bounded in front by the manubrium, behind by the first four dorsal vertebrae, and on each side by the mediastinal pleura. Its chief contents from before backwards are,

(1) Lymph glands and the atrophied remains of the thymus gland.

(2) The right and left innominate veins and the upper end of the superior vena cava.

(3) The right and left phrenic and the right and left vagus nerves.

(4) The arch of the aorta with its three great branches—the innominate, left common carotid and left subclavian arteries.

(5) The trachea.

(6) The oesophagus.

In addition the left recurrent laryngeal nerve and the thoracic duct will be found in close relation to the left side of the oesophagus.

The anterior mediastinum is a mere cleft between the back of the sternum and the pericardium. It is occupied by some adipose tissue and lymph glands.

The middle mediastinum contains the heart and pericardium, the ascending aorta, the pulmonary artery, the lower part of the superior vena cava with the arch of the vena azygos major, the roots of the two lungs, the bronchial lymph glands, and the two phrenic nerves.

The posterior mediastinum is the narrow space bounded in front by the pericardium, behind by the lower eight dorsal vertebrae, on each side by the mediastinal pleura, and below by the diaphragm. It contains the descending thoracic aorta with its branches, the vena azygos major, the vena azygos minor, the oesophagus, the thoracic duct, the two vagus nerves, the two great splanchnic nerves, and some lymph glands.

THE PERICARDIUM AND HEART.

The pericardium is the strong fibro-serous bag that encloses the heart. The fibrous bag is firmly attached below to the central tendon of the diaphragm, though it encroaches slightly on to the left cupola as well. When traced upwards it will be found to blend with the coats of the three great vessels at the base of the heart. Named from right to left, these are the superior vena cava the ascending aorta and the pulmonary artery. It encloses the whole of the aorta and the pulmonary artery, but only the lower half of the superior vena cava.

Open the fibrous bag crosswise in order to expose the serous layer. This consists of a parietal portion which closely lines the interior of the fibrous bag,

giving it its smooth glistening appearance, and a visceral layer which is reflected along the coats of the great vessels on to the surface of the heart where it forms the epicardium. On examining the relation of the serous pericardium to the great vessels it will be noted that the ascending aorta and pulmonary artery possess a common investment, which is explained very simply by the fact that they arise from the subdivision of a single vessel in embryonic life. The finger can thus be passed between these and the auricular portion of the heart, this cleft being termed the transverse sinus of the pericardium. In contrast to these vessels, the superior vena cava is covered only in front and at the sides. On tilting the apex of the heart well upwards a recess will be observed extending backwards behind the left auricle and between the right and left pulmonary veins. This is sometimes termed the oblique sinus of the pericardium. Another structure to be searched for is the vestigial fold of pericardium which extends from the left branch of the pulmonary artery to the upper left pulmonary vein. Between the layers of this fold are the obliterated remains of the left superior vena cava of the embryo.

The surface anatomy of the heart should be examined on the skeleton before proceeding further with the dissection. The right border of the heart, which is represented mainly by the right auricle, is indicated on the surface of the body by a line which curves outwards half an inch from the right border of the sternum, between the third costo-sternal junction and the fifth interspace at its sternal extremity The left border of the heart is indicated by a curved line, strongly convex outwards, which extends from the sternal end of the second left interspace to the position of the apex beat of the heart in the fifth left intercostal space three and one half inches from the mid line of the sternum. This border is represented mainly by the left ventricle. The lower border of the heart will thus be represented by a line, almost horizontal in direction, which connects the last mentioned point to the sternal extremity of the fifth right intercostal space. This border corresponds in great measure to the position of the right ventricle.

The coronary arteries which supply blood to the heart and the cardiac veins will require to be dissected out at this stage. The arteries lie in the auriculo-ventricular groove which maps off the auricular from the ventricular portion of the heart, but the presence of both is usually masked by a layer of adipose tissue under the epicardium. First of all, therefore, secure the arteries at their origin from the commencement of the ascending aorta and trace them to the right and left in the groove. The anterior and posterior interventricular vessels will be observed to map off the right and left ventricles from one another rather prominently.

The right coronary artery arises from the ascending aorta immediately above the anterior aortic valve, while the left takes origin above the left posterior valve. These arteries sweep to the right and left in the auriculo-ventricular groove, in which they encircle the heart, and end posteriorly by anastomosing slightly with each other. Each artery furnishes branches to the corresponding auricle and ventricle, and a well defined branch which runs downwards along the

corresponding margin of the heart. In addition the left coronary artery sends the anterior interventricular branch down the anterior interventricular groove, while the right furnishes the posterior interventricular artery for the posterior interventricular groove. These vessels supply twigs to both ventricles.

Most of the veins from the heart wall enter the coronary sinus which is a large dilated vein that will be found lying on the posterior aspect of the heart in the auriculo-ventricular groove between the left auricle and left ventricle. By its right end it joins the right auricle and by its left becomes continuous with the left or great cardiac vein which begins as the anterior interventricular vein, and while sweeping round the left side of the heart receives the veins corresponding to the other branches of the left coronary artery. The right cardiac vein accompanies the right coronary artery and is partly its vein of drainage. It enters the right end of the coronary sinus. Two or three prominent veins running upwards on the posterior aspect of the ventricular portion of the heart are termed the posterior cardiac veins. They enter the coronary sinus. The oblique vein is a minute structure which may be found on the posterior aspect of the left auricle. It enters the coronary sinus, and represents the lower part of the left superior vena cava of the embryo. The anterior cardiac veins, though small, may be observed on the anterior aspect of the right ventricle. They enter the cavity of the right auricle directly.

THE CAVITIES OF THE HEART.

It will be observed that the heart is rather cone shaped, the base being formed by the two auricles and the apex by the left ventricle. The right border of the ventricular portion is rather sharp, and its left border more full and rounded. These cavities will now have to be examined, and it is best to follow the course of the blood stream, and open the right auricle first of all. This is done by means of a vertical incision connecting the two venae cavae, from the middle of which a second incision is prolonged into the auricular appendix. The blood clot must be turned out, and the interior wiped out with a damp sponge.

THE RIGHT AURICLE.

The right auricle is triangular in outline, with an opening at each angle; the superior vena cava entering it from above, and the inferior vena cava from below, while the auriculo-ventricular orifice, which leads into the right ventricle, is directed forwards and to the left. At or near the centre of the posterior wall of the right auricle is an oval depression, the fossa ovalis, which in the foetus is a foramen, the foramen ovale, which leads into the left auricle. It will thus be recognised that the posterior wall of the right auricle is formed by the inter-auricular septum. The fossa ovalis is surrounded above and at the sides by a horse shoe shaped rim, (annulus ovalis), from the anterior edge of which a fold of endocardium (the lining membrane of the heart) passes to the inferior vena

caval opening. This is termed the Eustachian valve, and it is quite evident that its function in the foetus is to direct the stream of pure blood from the placenta, which enters the foetal heart through the inferior vena caval opening, into the left auricle and ventricle. By the side of the Eustachian valve is the opening of the coronary sinus, guarded by an imperfect valve, while scattered over the posterior surface of the auricle are the openings of a few small veins which drain the blood from the cardiac wall.

The anterior wall of the right auricle will be observed to be covered for the most part with small fleshy projections termed musculi pectinati. When traced to the right, however, these end in a vertical ridge, the crista terminalis, leaving the portion of the auricular cavity into which the venae cavae open, free from muscular projections. This portion corresponds to the Sinus venosus of the embryonic heart. The last feature to be noted in the right auricle is the auricular appendix which is a small recess from the anterior wall lined by musculi pectinati.

THE RIGHT VENTRICLE.

The right ventricle is next opened by an incision just to the right of the inter-ventricular groove, and one parallel to the auriculo-ventricular groove. Turn the flap to the right and clean out the cavity.

The right ventricle is also rather triangular in outline, on surface view, with two openings in its base—the right auriculo-ventricular or tricuspid aperture, and the opening of the pulmonary artery. It will be noted that the apex, which is directed downwards, does not form the apex of the heart. Examine first of all the three valvular cusps guarding each orifice, which it may be observed are arranged similarly, namely two in front and one behind. The flaps guarding the orifice of the pulmonary artery are semilunar pockets, hence their name of semilunar valves. The smooth cone shaped portion of the right ventricle which leads into the pulmonary artery is usually called the infundibulum, and the left anterior flap of the auriculo-ventricular valve which is nearest to it is called the infundibular flap. The others are termed the right or marginal and the posterior flaps. The interior of the right ventricle, except the infundibulum is lined by muscular ridges, the columnae carneae, of which three types may be identified. The first consists of simple ridges attached along their whole length, the second type is attached at both ends but free in the middle. The third type is represented by the musculi papillares, which are attached to the ventricular wall by one end, while the other affords attachment to delicate tendinous cords, the cordae tendineae, which pass to the adjacent margins and ventricular surfaces of the auriculo-ventricular valve flaps and keep them under control. It will be noted that there are only two musculi papillares—anterior and posterior. The cordae from the anterior muscle pass to the adjacent margins of the right and left flaps, while those from the posterior papillary muscle pass to the adjacent margins of the right and the posterior flaps. The adjacent margins of the posterior and the left flaps are controlled by short cordae tendineae which spring directly from the ventricular wall.

The moderator band is usually well defined and passes from the interventricular septum to the anterior wall of the right ventricle at the point of attachment of the anterior papillary muscle. It thus belongs to the second type of columnae carneae. It contains a large proportion of the fibres of the auriculo-ventricular bundle which passes from the interauricular down to the interventricular septum, and is supposed to convey the impulse to the ventricles to make them contract in the cardiac systole.

THE LEFT AURICLE.

The left auricle should now be opened by means of a transverse incision connecting the points of entrance of the right and left pulmonary veins. It is a transversely oval chamber, the right and left extremities of which receive two pulmonary veins from the corresponding lung. Each pair of veins may enter separately or by a common stem. A large part of the anterior wall of the left auricle is formed by the interauricular septum, but just to the left of this will be found the left auriculo-ventricular orifice and the opening into the left auricular appendix which is the only portion of the left auricle that can be seen from the front. Note that the musculi pectinati of the left auricle are confined entirely to the appendix.

THE LEFT VENTRICLE.

The left ventricle will now be opened by inserting the knife at the apex of the heart and cutting through both anterior and posterior walls of the chamber right up to its base. It will be observed that the cavity is cone shaped, and that its walls are three times thicker than the anterior wall of the right ventricle. The apex of the left ventricle forms the apex of the heart, and produces the apex beat that is felt during life in the fifth left interspace. At the base of the left ventricle are two openings of which the left auriculo-ventricular or mitral orifice is situated behind and to the left while the aortic opening is placed in front and to the right of this. Of the two flaps that guard the mitral orifice, one is situated in front and to the right and the other behind and to the left of the opening. Of the three semilunar valves that guard the aortic orifice one is placed anteriorly and the other two posteriorly. It will be noted that all three types of columnae carneae are strongly developed in the left ventricle. The two papillary muscles are very prominent as would be expected, and their cordae tendineae pass to the adjacent margins and ventricular surfaces of the mitral cusps. The portion of the left ventricle that leads into the aorta is comparatively smooth, and is termed the aortic vestibule. Its right wall, which is termed the membranous part of the interventricular septum, is comparatively thin, and may be the seat of congenital communication between the right and left ventricles.

THE AORTA.

The aorta is the great arterial trunk that leads from the heart. It is divided into three parts—the ascending aorta, the arch of the aorta, and the descending thoracic aorta. The dissector will require to clean up the first two parts at this stage and define their relationships.

THE ASCENDING AORTA.

The ascending aorta is situated in the middle mediastinum. Its course is upwards, forwards and to the right from the base of the left ventricle, and it ends behind the second right costo-sternal junction by becoming the aortic arch. It is enclosed throughout its whole course in the fibrous bag of the pericardium, and, moreover, is encased along with the pulmonary artery in a common sheath of serous pericardium. In front of it are the anterior edge of the right lung with the pleura, the right auricular appendix and the root of the pulmonary artery. To the left of it is the trunk of the pulmonary artery, while the right branch of the latter sweeps to the right behind it in order to reach the root of the right lung. The vena cava superior is to the right of the ascending aorta. The branches of the ascending aorta are the right and left coronary arteries, which have been already studied.

THE AORTIC ARCH.

The aortic arch is situated in the superior mediastinum. It arises behind the second right costo-sternal junction as a continuation of the ascending aorta and its course is backwards and to the left. It ends on the left side of the lower border of the fourth dorsal vertebra by becoming the descending thoracic aorta. In front it is overlapped by the left lung and pleura and is crossed by the left vagus and left phrenic nerves, as well as by two small cardiac twigs from the left vagus and sympathetic. Note that the phrenic nerve is to the right of the vagus. Another anterior relationship of the aortic arch is the left superior intercostal vein in its passage upwards to join the left innominate vein which is situated just above and in front of the aortic arch. Behind the arch are the bifurcation of the trachea, the deep cardiac plexus, the oesophagus, the left recurrent laryngeal nerve and the thoracic duct. Below the arch are the root of the left lung, the superficial cardiac plexus and the bifurcation of the pulmonary artery which is attached to the under aspect of the aortic arch by the ligamentum arteriosum, round which hooks the left recurrent laryngeal nerve. Superiorly the aortic arch gives off its three great branches which, named from right to left are, the innominate, the left common carotid and the left subclavian arteries.

The innominate artery inclines upwards and to the right on the lateral aspect of the trachea and, after a course of about one and a half inches, ends by dividing into the right common carotid and the right subclavian arteries. At first it

lies in front and then to the right of the trachea. The left innominate vein lies in front of it, and the right innominate vein is to its right side.

The left common carotid artery inclines upwards and to the left on the lateral aspect of the trachea and enters the neck. At first it lies in front and then to the left of the trachea. The left innominate vein is in front of it, while the left subclavian artery is behind and to its left.

The left subclavian artery arches upwards and to the left over the apex of the left lung and pleura in order to reach the root of the neck. In front of it are the left innominate vein, the left vagus and phrenic nerves and a few cardiac nerve twigs. The left common carotid artery is in front and to its right, between it and the trachea.

THE DESCENDING THORACIC AORTA.

The descending thoracic aorta will now require to be defined and cleaned and its various branches traced to their distribution as far as possible It begins on the left side of the lower border of the fourth dorsal vertebra as a continuation of the aortic arch. Its course is downwards and to the right on the dorsal vertebrae, and it ends at the lower border of the twelfth dorsal vertebra in the middle line of the body by passing through the diaphragm and becoming the abdominal aorta. Behind, it rests upon the lower eight dorsal vertebrae, though the vena azygos minor also crosses posteriorly to it at about the level of the eighth dorsal vertebra. In front from above downwards are the root of the left lung, the heart and pericardium and the sloping surface of the diaphragm, while the oesophagus also crosses in front of it just before piercing the diaphragm. To the left are the left lung and pleura. To the right are the thoracic duct, the Vena azygos major, the oesophagus, and at its lower end the right lung and pleura.

The branches of the descending thoracic aorta are—

(1) Nine pairs of intercostal arteries,
(2) Oesophageal branches,
(3) A pair of subcostal arteries,
(4) Bronchial (right and left),
(5) Pericardiac and mediastinal twigs.

The intercostal arteries supply the lower nine spaces on each side. Each sweeps outwards over a vertebra in order to pierce the posterior intercostal membrane, from which point the course and distribution have been previously studied. The right arteries are slightly longer and pass behind the thoracic duct and vena azygos major. Each intercostal artery gives off a dorsal branch which proceeds backwards between the transverse processes of the dorsal vertebrae in company with the posterior branches of the spinal nerves in order to supply the muscles and subcutaneous tissues of the back. Each dorsal branch on its passage backwards sends a small twig into the spinal canal to supply the spinal cord.

The oesophageal branches are four or five in number and take origin from the anterior aspect of the aorta.

Each subcostal artery accompanies the last dorsal nerve along the lower aspect of the twelfth rib, and passes forwards in the abdominal wall. It supplies the abdominal muscles and anastomoses with the lumbar arteries.

There are usually two bronchial arteries for the left lung and one for the right. They enter the root of the corresponding lung on the posterior aspect of the bronchus and supply the walls of the bronchial tubes.

The pericardiac and mediastinal twigs supply the pericardium, the lymph glands and the connective tissues of the posterior mediastinum.

THE PULMONARY ARTERY.

The pulmonary artery is situated in the middle mediastinum. It arises from the infundibulum of the right ventricle. At its origin it is directly in front of the ascending aorta, its trunk winds round the left side of this, and after a course of two inches it ends by dividing into right and left pulmonary arteries. It is enclosed within the fibrous bag of the pericardium throughout its course and is also enveloped together with the ascending aorta in a common sheath of serous pericardium. Its bifurcation is attached to the under aspect of the aortic arch by the ligamentum arteriosum which represents the obliterated remains of the ductus arteriosus, a channel which in the foetus conveys the impure blood from the right side of the heart into the aorta.

The position and relationships of the right and left pulmonary arteries within the roots of the corresponding lungs have been previously studied.

THE AZYGOS VEINS.

The vena azygos major enters the thorax through the aortic opening of the diaphragm to the right of the thoracic duct and the aorta. It maintains its relationship to these throughout its whole course in the posterior mediastinum. Posteriorly it rests on the dorsal vertebrae and the right aortic intercostal arteries, while in front of it lies the oesophagus. To its right are the right lung and pleura. The vena azygos major ends by arching forwards above the root of the right lung and joining the superior vena cava.

The tributaries of the vena azygos major are

(1) The lower eight right intercostal veins,

(2) The right superior intercostal vein, which drains the second and third intercostal spaces,

(3) The right subcostal vein,

(4) The right bronchial veins,

(5) The oesophageal veins,

(6) Pericardiac and mediastinal veins.

It also receives the vena azygos minor, which enters it by one or two stems.

The vena azygos minor enters the thorax by piercing the left crus of the diaphragm. It runs upwards on the left side of the vertebrae and receives the veins from the lower eight left intercostal spaces, the left subcostal vein and the left bronchial veins. It ends by passing behind the descending thoracic aorta and entering the vena azygos major by one or two stems. Above it usually communicates with the left superior intercostal vein. The latter drains the second and third spaces, and passes upwards in front of the aortic arch to join the left innominate vein. It should be noted here that the vein which drains the first intercostal space on each side, enters the corresponding innominate vein.

THE INNOMINATE VEINS AND THE SUPERIOR VENA CAVA.

Each innominate vein is formed at the inner border of the scalenus anterior by the union of the corresponding internal jugular and subclavian veins. The right innominate vein runs downwards on the right side of the innominate artery, while the left innominate vein crosses to the right directly in front of the three branches of the aortic arch. It joins the right innominate to form the superior vena cava behind the junction of the first right costal cartilage with the sternum.

Each innominate vein receives the first intercostal, the vertebral, the internal mammary and the inferior thyroid veins of the same side. The left innominate vein in addition receives the left superior intercostal vein and a few thymic and mediastinal twigs.

The superior vena cava begins behind the first right costo-sternal junction as already noted, and runs downwards to join the right auricle which it enters at the level of the third right costo-sternal junction. It is less than three inches long, and its lower half is enclosed by the pericardium.. In front and to the right it is in relation to the inner surface of the right lung which it grooves. Behind is the root of the right lung, while to the left is the ascending aorta.An important relation is the right phrenic nerve which runs downward on its right side. Its only tributary of note is the vena azygos major.

THE PHRENIC NERVES.

The phrenic nerves lie in the superior and middle mediastina. In the superior mediastinum the right phrenic nerve runs downwards between the superior vena cava and the inner surface of the right lung, while the left phrenic passes in front of the aortic arch and behind the left innominate vein. In the middle mediastinum both phrenic nerves run downward a short distance in front of the root of the corresponding lung, between the pericardium and the mediastinal pleura. As each nerve approaches the diaphragm it breaks up into small branches which pierce the corresponding cupola to supply it from its under surface.

THE VAGUS NERVES.

The vagus nerves are situated in the superior and posterior mediastina. In the superior mediastinum the right vagus nerve runs downwards on the right side of the trachea and in contact with the right pleura and lung, while the left crosses in front of the aortic arch to the left of the phrenic and behind the left innominate vein. Each nerve then passes to the posterior aspect of the root of the corresponding lung where it breaks up into the posterior pulmonary plexus Just before doing so, each vagus nerve sends a few twigs in front of the root of the lung to form the anterior pulmonary plexus. Each vagus nerve emerges intact from the posterior pulmonary plexus, and immediately passes to the oesophagus in the posterior mediastinum. This they enclose in a plexus termed the oesophageal plexus, the portion derived from the left vagus being mainly in front and that from the right behind. Each nerve becomes again reformed, and they pass through the oesophageal opening in the diaphragm, the left being still in front and the right behind the oesophagus.

In the thorax each vagus gives off twigs to the lungs (from the pulmonary plexuses) and branches to the cardiac plexus, to the oesophagus and to the pericardium. The left vagus in addition gives off the left recurrent laryngeal nerve which hooks round the attachment of the ligamentum arteriosum to the aortic arch, and then runs upwards in the groove between the trachea and oesophagus to reach the neck. In the abdomen the left vagus gives branches to the anterior surface of the stomach and to the liver, while the right supplies the posterior surface of the stomach and also sends branches to the spleen and pancreas.

The cardiac plexus of nerves is formed mainly by six branches from the cervical sympathetic and two branches from each vagus in the neck. It is massed chiefly behind the aortic arch and in front of the bifurcation of the trachea, though a small portion termed the superficial cardiac plexus lies in the concavity of the aortic arch. The offshoots from the cardiac plexus closely follow the course and distribution of the coronary arteries in the heart wall.

THE TRACHEA IN THE THORAX.

The trachea is situated partly in the neck and partly in the thorax, where it lies in the superior mediastinum. It bifurcates into the right and left bronchi at the level of the manubrio-sternal junction;or opposite the disc between the fourth and fifth dorsal vertebrae. It is situated throughout its course in the middle line of the body. In front are the arch of the aorta with the origins of the innominate and left common carotid arteries, and the cardiac plexus. The left innominate vein is also in front of it a little higher up. Behind is the oesophagus with the left recurrent laryngeal nerve lying between the two on their left sides. To the right of the trachea are the right vagus, the right lung with the pleura and the innominate artery, while to the left are the left common carotid and left subclavian arteries.

The two bronchi have been already studied in the roots of the lungs where they were found to be posterior to the pulmonary artery and veins. Note that the right bronchus is larger than the left, is more in line with the trachea than the left, and is shorter than the left, as it gives off a large branch to the upper lobe of the right lung very soon after its origin.

THE OESOPHAGUS IN THE THORAX.

The oesophagus is situated in the neck, thorax and abdomen. In the thorax it lies in the superior and posterior mediastina. Above it is slightly to the left of the middle line, lower down it inclines slightly to the right and it again passes very gently towards the left as it approaches the diaphragm, which it pierces in company with the right and left vagus nerves as previously noted.

In the superior mediastinum the oesophagus has the trachea and aortic arch in front of it, the first four dorsal vertebrae with the longus colli muscles behind it, and the left recurrent laryngeal nerve and the thoracic duct to its left side, thus intervening between it and the left lung and pleura. The oesophagus owing to its slight inclination to the left is not in close relation to the right lung and pleura in the superior mediastinum.

In the posterior mediastinum the oesophagus has the heart and pericardium and the sloping surface of the disphragm in front of it. Posteriorly are the vena azygos major and the thoracic duct, though lower down the oesophagus also comes to lie in front of the descending thoracic aorta. To the right are the right lung and pleura, and to the left the descending thoracic aorta at first and lower down the left lung and pleura to a slight degree. In the posterior mediastinum the oesophagus is surrounded by the oesophageal plexus, as already noted.

THE THORACIC SYMPATHETIC.

Remove the remains of the pleura from the posterior thoracic wall in order to expose the sympathetic cord which will be found running down on each side upon the heads of the ribs. Above it enters the thorax in front of the neck of the first rib where it lies to the inner side of the superior intercostal artery. The ganglia will usually be found resting upon the heads of the ribs. Towards the lower part of the thorax it comes to lie on the sides of the vertebrae, and it enters the abdomen by passing behind the internal arcuate ligament. Eleven ganglia are usually all that can be counted. These communicate externally with the spinal nerves by rami communicantes. The thoracic sympathetic gives minute twigs to the cardiac and pulmonary plexuses, but its chief branches are the three splanchnic nerves of which the great arises from the sixth, seventh, eighth, ninth and tenth ganglia, the lesser from the tenth and eleventh and the least, when present, from the eleventh ganglion. The splanchnic nerves run downwards by the sides of the vertebrae and pierce the corresponding crus of the diaphragm in order to join the solar plexus in the abdomen.

THE THORACIC DUCT.

The thoracic duct is the important channel along which the lymph from the two lower limbs and from the trunk below the level of the diaphragm is drained into the blood stream. In its passage upwards through the thorax the thoracic duct receives also the lymph from the left half of the thorax, while at the root of the neck it is joined by the main lymph ducts from the left upper limb and from the left half of the head and neck. The thoracic duct enters the thorax through the aortic opening of the diaphragm, between the aorta and the vena azygos major. It maintains its relation to these structures throughout its course in the posterior mediastinum. Opposite the fifth dorsal vertebra it inclines slightly to the left, and runs upwards in the superior mediastinum on the left side of the oesophagus. At the root of the neck it arches outwards behind the left common carotid artery, and terminates in the angle of junction between the left internal jugular and left subclavian veins.

Lymphatic glands will be found in each mediastinum. The most important ones are those found in the middle mediastinum. They are massed mainly around the entrance of the bronchi into the lungs, and are usually termed the bronchial glands. They receive the lymph drainage from the lungs, and therefore become very dark coloured in old age from absorption of soot particles, particularly in city dwellers.

Another important group of glands in the thorax is that arranged along the course of the internal mammary artery. It receives the drainage from the inner part of the anterior chest wall including the inner one third of the mamma in the female. This group is thus of great significance in reference to mammary carcinoma.

THE DISSECTION OF THE ABDOMEN.

THE ANTERIOR ABDOMINAL WALL.

The following eight layers will be identified in the anterior abdominal wall—

(1) Skin,
(2) Superficial fascia,
(3) The external oblique muscle,
(4) The internal oblique muscle,
(5) The transversalis muscle,
(6) The transversalis fascia,
(7) The extraperitoneal fatty tissue,
(8) The peritoneum.

These eight layers are very important in relation to the coverings of inguinal hernia. and must likewise be kept in mind when the surgeon is operating on the abdomen.

The following cutaneous nerves will be found in this region. Emerging through the anterior wall of the rectus sheath by the side of the middle line are the anterior cutaneous branches of the lower six intercostal nerves, while on the lateral aspect of the trunk will be found the lateral cutaneous branches of the same nerves. Nearer the iliac crest the ilio-hypogastric and last dorsal nerves may be discovered passing downward into the gluteal region. The ilio-inguinal nerve will be secured as it emerges through the subcutaneous inguinal ring along with the spermatic cord or round ligament, while about one inch above this the terminal branch of the ilio-hypogastric nerve pierces the aponeurosis of the external oblique muscle.

The deep layer of the superficial fascia blends with the fascia lata of the thigh approximately along the line of the inguinal ligament—a fact which is of some surgical importance.

THE ABDOMINAL MUSCLES.

The external oblique muscle will require to be cleaned and its attachments defined. It arises from the outer surfaces of the lower eight ribs by digitations, of which the upper five interdigitate with the serratus and the lower three with the latissimus dorsi. The muscle fibres are directed downwards and forwards, and give place to a strong aponeurosis which is inserted along the length of the lines alba, which represents the intersection of the aponeuroses of the abdominal muscles in the middle line of the anterior abdominal wall. The external oblique is likewise inserted into the anterior aspects of both pubic bones. Between the pubic spine and the anterior superior iliac spine the aponeurosis is folded upon its deep surface to form the inguinal ligament. The posterior portion of the external oblique is inserted by fleshy fibres into the anterior half of the outer lip of the iliac crest. The posterior edge of the muscle is free and assists the anterior border of the latissimus dorsi in bounding a small triangle (Petit's triangle), the base of which is formed by the iliac crest. The external oblique muscle is supplied by the lower six intercostal nerves, and it is a muscle of expiration. This muscle must now be detached from its origin and also from the iliac crest, and turned forwards in order to expose the internal oblique muscle which will now be cleaned and defined.

The internal oblique arises from the outer half of the inguinal ligament from the anterior two thirds of the middle lip of the iliac crest and from the lumbar fascia. The fibres are directed upwards and inwards, and obtain insertion into the lower six costal cartilages, and also into an aponeurosis which blends with the linea alba throughout its whole length. Note specially that the fibres which arise from the inguinal ligament arch inwards and blend with the corresponding fibres of the transversalis to form the conjoint tendon which is inserted into the pubic crest and also into the ilio-pectineal line for about an inch. The nerve supply and the action of the internal oblique are the same as those of the external oblique. This muscle may now be reflected forwards from

its origin and also from the costal cartilages. This is an operation of some difficulty owing to the presence of the intercostal nerves and vessels on its deep surface.

The transversalis muscle arises from the outer third of the inguinal ligament, from the anterior two thirds of the inner lip of the iliac crest, from the lumbar aponeurosis and from the lower six costal cartilages. The muscle fibres are for the most part directed transversely inwards to their insertion into the whole length of the linea alba. The fibres that take origin from the inguinal ligament, however, arch inwards to blend with the conjoint tendon, as already noted. The nerve supply and action of the transversalis are the same as those of the two oblique muscles.

THE RECTUS SHEATH.

The rectus sheath has now to be opened longitudinally. Difficulty will be experienced in reflecting the anterior wall of the sheath from the muscle owing to its blending with the three tendinous intersections. The sheath contains two muscles—the rectus and pyramidalis, two arteries—the superior and deep epigastric, and two sets of nerves—the lower six intercostal and the last dorsal.

The rectus arises by an outer head from the pubic crest and an inner head from the ligaments in front of the symphysis. The muscle is inserted into the fifth, sixth and seventh costal cartilages. It is supplied by the lower six intercostal nerves, which pierce it. It is a muscle of expiration and also anteflexes the trunk. It possesses three transverse tendinous intersections, of which one is situated opposite the umbilicus, one opposite the ensiform cartilage and one midway between these. A fourth intersection is sometimes present midway between the umbilicus and the pubes. They represent body segmentation.

When the rectus muscle is contracted in the living subject the outer edge of its sheath is represented by a well marked groove. This is known as the linea semilunaris, and is a frequent site for incisions in abdominal operations.

The pyramidalis is only occasionally present and arises from the ligaments in front of the pubes. Its insertion is into the linea alba. It is innervated by the last dorsal nerve, and its action is to exert traction upon the linea alba.

The superior and deep epigastric arteries will be found running downwards and upwards respectively upon the deep surface of the rectus, and supplying it. The superior epigastric has been previously studied in the thorax. The whole course and distribution of the deep epigastric artery will be studied later.

The last dorsal and the lower six intercostal nerves run forwards in the abdominal wall between the internal oblique and transversalis muscles. They enter the rectus sheath by piercing the posterior lamella of the internal oblique aponeurosis. The lower six intercostal nerves traverse the substance of the rectus muscle, supply it, and then emerge through the anterior wall of the sheath

as the anterior cutaneous nerves which have been previously studied. The last dorsal nerve supplies the pyramidalis.

Cut through the rectus about its middle in order to study the mode of formation of the rectus sheath which is as follows. The aponeurosis of the internal oblique muscle on reaching the outer border of the rectus splits into anterior and posterior lamellae of which the former blends with the external oblique aponeurosis and the latter with the transversalis aponeurosis. Below a point midway between the umbilicus and the pubes, however, all three aponeuroses come to the front of the rectus, thus leaving a free edge of the posterior wall, termed the semilunar fold, at the above level. Therefore the lower portion of the posterior wall of the rectus sheath has to be completed by the next layer of the abdominal wall, namely the transversalis fascia.

THE INGUINAL CANAL.

The anatomy of the inguinal canal and of inguinal hernia must be studied next. Begin by detaching the aponeurosis of the external oblique from the inguinal ligament. Lift up the lower border of the internal oblique and define the spermatic cord if the subject be a male, or the round ligament of the uterus in the case of a female. The ilio-inguinal nerve will likewise be found in the canal in both sexes. The next step is to detach the internal oblique and transversalis fibres from the inguinal ligament, taking care meanwhile not to damage the deep circumflex iliac artery in so doing. On lifting these muscles upwards, the spermatic cord or round ligament will be found emerging through the transversalis fascia at the abdominal inguinal ring.

The inguinal canal is an oblique passage through the layers of the abdominal wall. It is one and a half inches long and is situated immediately above the inner half of the inguinal ligament. It transmits the spermatic cord and its coverings in the male, and the round ligament of the uterus in the female, as well as the ilio-inguinal nerve in both sexes. Its superficial opening, termed the subcutaneous inguinal ring, is an opening in the external oblique aponeurosis situated just above the inner end of the inguinal ligament. Strictly speaking there is no opening, seeing that the margins are prolonged downwards over the spermatic cord and testis as one of their coverings termed the external spermatic fascia. The deep opening of the inguinal canal, or abdominal inguinal ring, is in the fascia transversalis and is situated at a point about half an inch above the inguinal ligament, and midway between the anterior superior spine and the pubic symphysis. Here again there is no opening since its margins are also prolonged downwards over the spermatic cord and testis as the internal spermatic fascia. The anterior wall of the canal is composed of the aponeurosis of the external oblique and the lower border of the internal oblique, while the posterior wall presents from without inwards the fascia transversalis, the conjoint tendon and a few reflected fibres from the external oblique aponeurosis of the opposite side. The floor is formed by the inguinal ligament and the

lacunar ligament which is a very small structure fitting into the angle between the inner end of the inguinal ligament and the ilio-pectineal line. The roof of the canal is simply formed by the approximation of the anterior and posterior walls above the contents.

THE SPERMATIC CORD.

The spermatic cord possesses three sheaths or coverings derived from the layers of the abdominal wall namely—

(1) The external spermatic fascia from the external oblique aponeurosis,

(2) The cremaster muscle which consists of a series of loops pulled away from the lower border of the internal oblique. The cremaster has a special nerve supply from the genito-femoral nerve.

(5) The internal spermatic fascia which is derived from the transversalis fascia. Note once more that these three coverings are prolonged downwards as consituents of the wall of the scrotum.

The constituents of the spermatic cord are—

(1) The ductus deferens.

(2) The spermatic artery.

(3) Three spermatic plexuses—veins, nerves and lymphatics.

(4) Three other structures—the artery and nerve to the cremaster muscle and the artery to the ductus deferens. It is difficult to identify all these structures, though the ductus is readily recognised by the fact that it feels like a piece of cord. The spermatic plexus of nerves is derived from the sympathetic system, and comes from the aortic plexus. The spermatic lymphatics from the testicle pass to the glands by the side of the abdominal aorta.

THE SCROTUM AND TESTIS.

Incise downwards through the wall of the scrotum along the line of the spermatic cord and expose the testis by cutting vertically through its coverings. Note that underneath the skin of the scrotum is a layer of nonstriated muscle, the dartos muscle, which entirely replaces the subcutaneous fat in this region, and causes the wrinkling of the scrotal wall. In addition to these layers the testicle is likewise covered by the external spermatic fascia, cremasteric muscle, the internal spermatic fascia and the tunica vaginalis which constitutes its serous covering, and therefore consists of parietal and visceral layers, the line of reflection between the two being along the posterior border of the testis.

The testis consists of a body along the posterior border of which is moulded the elongated epididymis, which overlaps the testis externally, a small recess termed the digital fossa intervening between the two, and indicating the side to which the testis belongs. The body is ovoid in shape and hangs with its long axis more or less vertical. It possesses a smooth glistening appearance produced by the visceral layer of the tunica vaginalis. On its upper pole close to the epididymis two minute bodies, one stalked the other unstalked, may be

found. These are the hydatids and are embryonic remnants, the stalked one representing the remains of the pronephros and the unstalked one the remains of the Mullerian duct. The epididymis consists of an enlarged upper end or head, which overhangs the upper pole of the testis, an elongated body and an attenuated lower end or tail. It contains a tube, the canal of the epididymis, coiled to an amazing degree, which becomes continuous with the ductus deferens. The latter emerges from the tail of the epididymis and then runs upwards on its inner side.

Make a horizontal section through the body of the testis in order to glean some knowledge of its structure. Note that immediately underneath the tunica vaginalis it is encased in a strong resistant capsule termed the tunica albuginea from which fibrous septa pass backwards towards the posterior border of the gland thus dividing it into compartments. The latter contain the much coiled and convoluted seminiferous tubules which join to form a plexus towards the posterior border of the testis. This plexus is drained by the vasa efferentia into the canal of the epididymis.

INGUINAL HERNIA.

The complete course of the deep epigastric artery must now be examined as a prelude to the study of inguinal hernia. This vessel arises from the external iliac artery one quarter of an inch above the inguinal ligament. It is directed upwards and inwards behind the fascia transversalis and passes to the inner side of the abdominal inguinal ring. It soon pierces the fascia transversalis and then enters the rectus sheath in front of the semilunar fold. The deep epigastric artery ends by anastomosing with the superior epigastric. It gives off muscular twigs to the rectus, cutaneous branches which accompany the anterior cutaneous nerves, the artery to the cremaster muscle and a branch which anastomoses with the obturator artery. This explains the mode of formation of the abnormal obturator artery which has been already mentioned in connection with femoral hernia.

Oblique inguinal hernia emerges through the abdominal inguinal ring, and traverses the inguinal canal. If large it may protrude through the subcutaneous inguinal ring and finally extend downwards into the scrotum. It has therefore the same coverings as the spermatic cord namely the internal spermatic fascia, the cremaster muscle the external spermatic fascia, the superficial fascia and the skin. In addition the hernial sac is formed from a protrusion of the peritoneum.

Direct inguinal hernia is protruded through the area known as Hesselbach's triangle. This is bounded externally by the deep epigastric artery, internally by the outer border of the rectus sheath and below by the inguinal ligament. In addition to the peritoneal hernial sac its coverings are the transversalis fascia, the conjoint tendon, the external spermatic fascia, the superficial fascia and skin.

The tunica vaginalis is developed as a protrusion of the peritoneum, which is pulled downwards into the scrotum during foetal life. This communication

may remain open and a hernia be forced downwards into it. This is known as *congenital hernia.* A second peritoneal sac may be pulled downwards into the scrotum behind the tunica vaginalis during foetal life. A hernial protrusion may be forced downwards into this sac, constituting *infantile hernia.*

It is convenient to study the deep circumflex iliac artery at this stage. It arises from the outer aspect of the external iliac one quarter of an inch above the inguinal ligament. It runs outwards along this ligament, and on the way pierces first the transversalis fascia and then the transversalis muscle. The artery is continued along the iliac crest between the transversalis and internal oblique muscles, and it ends by anastomosing with the superior gluteal and with the lumbar arteries.

The abdominal cavity has now to be opened by a vertical incision through the linea alba and a transverse incision extending outwards on each side from the umbilicus. The four flaps are then to be turned aside.

Upon examining the peritoneal surface of each lower flap, two ridges directed upwards and inwards towards the umbilicus may be detected. The outer one is produced by the deep epigastric artery, and the inner one by the obliterated hypogastric artery. In this manner the external, middle and internal inguinal fossae are produced. The external fossa is to the outer side of the lower end of the external ridge, and corresponds to the position of the abdominal inguinal ring. It therefore indicates the site of the first protrusion of an oblique inguinal hernia. The middle and internal inguinal fossae are placed on either side of the lower end of the internal ridge. They correspond to the floor of Hesselbach's triangle. Therefore a direct inguinal hernia may protrude either external or internal to the obliterated hypogastric artery.

THE PERITONEUM.

The peritoneum is the glistening serous membrane that lines the abdominal cavity. It is also reflected over the viscera as coverings for these. Its arrangement is complicated, and it is best to study it first of all in mesial vertical section. Begin first of all with the great omentum which is the structure loaded with fat that hangs downwards apron-like over the intestines. This consists of two anterior and two posterior peritoneal layers which are continuous below at the free lower border of the structure. The two anterior layers of the great omentum, when traced upwards, reach the greater curvature of the stomach where they separate to enclose this viscus. They meet again at the lesser curvature of the stomach, from which they pass to the transverse fissure of the liver as the gastro-hepatic omentum. At the transverse fissure of the liver these two layers separate, and we will leave the posterior layer at this point, and trace the anterior layer forwards round the sharp margin of the liver, and then upwards on the anterior and upper surfaces of that organ. Here it is reflected on to the under surface of the diaphragm, and is continued downwards on the anterior abdominal wall, where it will also be left for the present.

On turning now to the two posterior layers of the great omentum and tracing them upwards it will be found that they separate to enclose the transverse colon, from which they are continued upwards and backwards to the posterior abdominal wall as the mesentery of the transverse colon. The attachment of the latter will be found to be along the lower border of the pancreas, where its two layers separate. The uppermost is directed upwards in front of the pancreas and the upper end of the abdominal aorta on to the diaphragm, from which it is reflected on to the posterior and under aspects of the liver where it becomes continuous with the posterior layer of the gastro-hepatic omentum which we left at the transverse fissure of the liver. The lower layer of the mesentery of the transverse colon which we left at the lower border of the pancreas is almost immediately reflected from the posterior abdominal wall to form the mesentery of the small intestines. It is then continued downwards over the lower end of the posterior abdominal wall into the pelvis, and finally sweeps upwards on the anterior abdominal wall to become continuous with the layer we left there.

The arrangement of the peritoneum just described should be drawn on the black board in the form of a diagram. On doing so it will be observed that two peritoneal sacs have been outlined. These are the greater and lesser sacs of peritoneum, of which the former is the one that has been exposed in opening the abdominal cavity. The lesser sac is an extensive recess leading from this, and the opening of communication between the two is termed the foramen of Winslow. The latter opening will be discovered on passing the finger to the left behind the right free border of the gastro-hepatic omentum. It should be noted at this point that the two layers of peritoneum which enclose the stomach, also envelop the first inch of the duodenum. Therefore the right free border of the gastro-hepatic omentum passes really from the duodenum. It will be found to contain the portal vein, the hepatic artery, the common bile duct and a few lymphatic vessels and glands. The portal vein is the most posterior structure, the hepatic artery being in front and to the left and the common bile duct in front and to the right. The upper boundary of the foramen of Winslow is formed by the under surface of the liver, the posterior by the inferior vena cava and the lower boundary by the first part of the duodenum along with the hepatic artery as it curves forwards.

The boundaries of the lesser sac are as follows. The anterior wall is formed by the liver, gastro-hepatic omentum, stomach and the two anterior layers of the great omentum; while its posterior wall is formed by the two posterior layers of the great omentum, the transverse colon, the mesentery of the transverse colon, and the peritoneum covering the posterior abdominal wall including the pancreas. The lesser sac extends to the left as far as the spleen, while its right limit is at the foramen of Winslow.

It will now be necessary to study the disposition of the peritoneum in a horizontal direction, and this is best done at the level of the foramen of Winslow and at the level of the umbilicus.

From the right free border of the gastro-hepatic omentum, its two layers pass towards the left, and reach the lesser curvature of the stomach where they separate to enclose that viscus. The two layers meet again at the fundus of the stomach, from which they pass to the inner surface of the spleen as the gastro-splenic omentum. The latter is attached just in front of the hilum of the spleen, while immediately behind this point two layers of peritoneum pass from the spleen to the anterior surface of the left kidney, to form the splenico-renal ligament. The two layers of the latter separate on the surface of the left kidney, one of which sweeps to the left over the diaphragm and thence on to the anterior abdominal wall ; while the other layer passes to the right over the left kidney, the aorta, the inferior vena cava and the right kidney, finally passing forwards over the diaphragm to meet the layer from the left side on the anterior abdominal wall. At this level the peritoneum is carried off from the middle line of the anterior abdominal wall by the ligamentum teres of the liver to form the falciform ligament of the liver.

The disposition of the peritoneum in a horizontal direction is very simple at the level of the umbilicus; for it will be observed that the right or upper layer of the mesentery of the small intestines sweeps to the right, and after covering the ascending colon in front and at the sides, is continued on to the anterior abdominal wall. Similarly, the left or lower layer of the mesentery of the small intestines, when traced towards the left, invests the descending colon in front and at the sides, and is then continued forwards to meet the layer from the opposite side on the anterior abdominal wall.

An omentum is a fold of peritoneum which connects the stomach to a neighboring viscus. There are three omenta—the great or gastro-colic omentum, the lesser or gastro-hepatic omentum, and the least or gastro-splenic omentum.

A mesentery is a fold of peritoneum which connects any part of the intestine to the posterior abdominal wall. There are four mesenteries—the mesentery of the small intestines, the mesentery of the transverse colon, the mesentery of the pelvic colon and the mesentery of the vermiform appendix.

Ligament is the general term applied to a fold of peritoneum which connects viscera to the abdominal wall or to one another.

There are certain fossae in connection with the peritoneum which are important clinically owing to the fact that a coil of intestine may become strangulated in one of these. The retro-coecal fossa, as its name implies, will be found on lifting the coecum forwards. One or more of these fossae may frequently be found just to the left of the duodeno-jejunal flexure, while a well marked one can usually be detected in the angle of the V shaped mesentery of the pelvic colon.

Before proceeding to the study of the viscera it is necessary to note that the abdominal cavity is divided into nine regions by two horizontal and two vertical planes. In this way the positions of the various viscera can be located much more readily. The upper horizontal plane, termed the sub-costal plane, passes through the most dependent parts of the tenth costal cartilages, while the lower horizontal plane is situated at the level of a prominent tubercle which

will be found on the outer lip of each iliac crest about two and one half inches behind the anterior superior spine. It is therefore known as the inter-cristal plane.

The two vertical planes pass through the mid points of the right and left inguinal ligaments, and might therefore be named the mid-inguinal planes. Of the nine regions thus mapped out, the three in the uppermost row are named as follows from the right to left—the right hypochondriac, epigastric and left hypochondriac regions. The three in the intermediate row are the right lumbar, the umbilical and left lumbar regions, while those of the lowermost row are the right iliac, the hypogastric and the left iliac regions.

DISSECTION.—The intestines have to be removed very early in order to obtain a satisfactory view of the other viscera. It is therefore necessary to study the course and distribution of the superior and inferior mesenteric arteries, and of the coeliac axis artery. Remove first of all the anterior layer of the mesentery of the small intestines very carefully in order to display the distribution of the superior mesenteric artery. This also involves the removal of the lower layer of the mesentery of the transverse colon and also some of the peritoneum on the posterior abdominal wall.

THE SUPERIOR MESENTERIC ARTERY.

The superior mesenteric artery arises from the anterior aspect of the abdominal aorta behind the pancreas. It passes downwards in front of the recurved portion of the head of the pancreas, and after crossing in front of the third part of the duodenum, enters the root of the mesentery of the small intestines. It curves gently towards the right between the layers of the mesentery, and it ends by anastomosing with the ileo-colic artery, which is one of its own branches. The superior mesenteric artery is accompanied by the corresponding vein which lies to its right throughout its course. The branches of this artery are

(1) Branches to the small intestine.
(2) Ileo-colic artery.
(3) Right colic artery.
(4) Middle colic artery.
(5) Inferior pancreatico-duodenal artery.

The branches to the small intestines are 12 to 16 in number and spring from the left or convex side of the artery. They pass downwards towards the small intestine, and each divides into two branches which unite with their neighbours to form a row of arterial arches. From the summits of these a second series of arteries, much more numerous, arise, and each of these again divides to form with their neighbours a second row of arterial arches, from which innumerable terminal arteries pass to supply the wall of the intestine.

The ileo-colic artery springs from the right side of the superior mesenteric towards its termination, and passes to the right in order to escape from the root of the mesentery. It then divides into ileal and colic branches, of which the ileal

supplies the lower end of the ileum and also anastomoses with the terminal branch of the superior mesenteric; while the colic branch supplies the lower part of the ascending colon and anastomoses with the right colic artery. The ileo-colic artery also gives off the anterior and posterior coecal arteries which supply the anterior and posterior aspects of the coecum respectively, as also the artery to the appendix which passes downwards behind the termination of the ileum and then runs along the free edge of the mesentery of the appendix which it supplies.

The right colic artery arises from the right side of the superior mesenteric just above the ileo-colic artery, and very often in common with it. After escaping from the root of the mesentery it passes towards the ascending colon which it supplies by means of ascending and descending branches, of which the former anastomoses with the middle colic and the latter with the ileo-colic, as previously shown.

The middle colic artery arises just as the superior mesenteric is crossing the third part of the duodenum, and passes forward between the layers of the mesentery of the transverse colon which it supplies by means of right and left branches of which the former anastomoses with the right colic in the vicinity of the hepatic flexure of the colon while the latter anastomoses with the left colic artery in the neighbourhood of the splenic flexure.

The inferior pancreatico-duodenal artery takes origin from the superior mesenteric just before it crosses the third part of the duodenum. It curves upwards between the latter and the head of the pancreas, and after dispensing branches to both, ends by anastomosing with the superior pancreatico-duodenal artery.

DISSECTION.—The course and distribution of the inferior mesenteric artery must now be displayed. First of all locate its origin which is 1½ inches above the bifurcation of the aorta and strip off the peritoneum of the posterior abdominal wall along the artery and its branches.

THE INFERIOR MESENTERIC ARTERY.

The inferior mesenteric artery arises from the anterior (and left) aspect of the abdominal aorta 1½ inches above its bifurcation. It runs downwards and to the left on the front of the main vessel and then crosses in front of the left common iliac artery. It thus enters the pelvis and automatically changes name into superior haemorrhoidal. The artery runs downwards behind the commencement of the rectum, and soon divides into right and left branches which pierce the muscular wall of the gut to anastomose in the sub-mucous layer with the right and left middle haemorrhoidal arteries. The branches of the inferior mesenteric artery are the left colic and sigmoid arteries.

The left colic artery runs towards the left behind the peritoneum on the posterior abdominal wall in order to reach the descending colon which it supplies by means of ascending and descending branches, of which the former anastomoses with the middle colic and the latter with the sigmoid arteries.

The sigmoid arteries are two or three in number and supply the iliac colon and the pelvic colon. They form a chain of anastomoses with one another on the wall of the bowel, and also with the neighboring branches of the inferior mesenteric artery.

Before leaving the study of the inferior mesenteric artery it should be noted that the corresponding vein does not accompany it closely, but lies slightly more to the left as it courses upwards to join the splenic vein.

DISSECTION.—The coeliac axis artery has now to be exposed. Pull away the greater part of the gastro-hepatic omentum and pull the stomach downwards. The tortuous splenic artery will be detected running along the upper border of the pancreas. Remove the peritoneum towards the right along its course, and the main artery with its hepatic and coronary branches will be readily found. Trace the course and distribution of the coronary artery first of all and then sever the oesophageal end of the stomach in order to be able to turn the latter downwards, thus giving a better view of the splenic artery.

THE COELIAC AXIS ARTERY.

The coeliac axis artery arises from the anterior aspect of the abdominal aorta immediately above the upper border of the pancreas. After a course of about one quarter of an inch it divides into the coronary, hepatic and splenic arteries. It lies behind the peritoneum on the posterior wall of the lesser sac.

The coronary artery is directed upwards and to the left towards the oesophageal opening of the stomach, and behind the peritoneum on the posterior wall of the lesser sac. It divides into an oesophageal branch which passes upwards through the oesophageal opening of the diaphragm to anastomose with the oesophageal branches of the thoracic aorta, and a gastric branch, which sweeps to the right between the layers of the gastrohepatic omentum along their lines of attachment to the lesser curvature of the stomach. It dispenses branches to both surfaces of this viscus and ends by anastomosing with the pyloric branch of the hepatic.

The hepatic artery passes forwards and to the right below the foramen of Winslow, and then turns upwards in the right free border of the gastrohepatic omentum in order to reach the liver, where it ends by dividing into right and left terminal branches. The right is the larger of the two, and they enter the two extremities of the transverse fissure in order to supply the supporting tissue of the liver. Note that the right branch also supplies a small cystic artery to the walls of the gall bladder. The other branches of the hepatic artery are the pyloric and gastro-duodenal arteries.

The pyloric artery passes to the left along the lesser curvature of the stomach between the layers of the gastro-hepatic omentum. It is very small and ends by anastomosing with the gastric artery as previously noted.

The gastro-duodenal is a well marked branch which proceeds downwards behind the first part of the duodenum and then divides into the right gastro-epiploic and superior pancreatico-duodenal arteries. The former of these is

directed towards the left along the greater curvature of the stomach and between the layers of the great omentum. It dispenses branches to both surfaces of the stomach and to the omentum, and ends by anastomosing with the left gastro-epiploic artery. The superior pancreatico-duodenal artery curves downwards between the duodenum and the head of the pancreas, supplies branches to both, and ends by anastomosing with the inferior pancreatico-duodenal, as already shown.

The splenic artery is the largest branch of the coeliac axis and exhibits a very tortuous course along the upper border of the pancreas, behind the peritoneum on the posterior wall of the lesser sac. At the same time it passes in front of the left kidney and reaches the hilum of the spleen between the layers of the splenico-renal ligament, where it ends in terminal splenic branches. It also supplies numerous branches to the body of the pancreas, and in addition gives off the vasa brevia and left gastro-epiploic branches which reach the stomach between the layers of the gastro-splenic omentum. The vasa brevia supply the fundus of the stomach and anastomose with the gastric branch of the coronary artery; while the left gastroepiploic courses to the right along the line of attachment of the great omentum to the greater curvature of the stomach to anastomose with the right gastro-epiploic artery. In this way the stomach is surrounded by a complete ring of anastomoses.

THE STOMACH.

The stomach possesses an oesophageal opening, a pyloric opening, lesser and greater curvatures, anterior and posterior surfaces The fundus is the name given to that portion which bulges upwards and to the left above the level of the oesophageal opening, Occasionally a slight constriction may be detected on the greater curvature a short distance from the pylorus. This suggests a division of the stomach into two chambers, of which the larger portion towards the left is the body while that next to the pylorus is the pyloric portion. The stomach is situated in the epigastric and left hypochondriac regions of the abdomen.

The position of the oesophageal opening of the stomach is indicated on the surface of the body by a point on the seventh left costal cartilage one inch from its junction with the sternum. Note that the opening is over four inches from the surface and is situated at the level of the tenth dorsal vertebra.

The pyloric opening lies in the transpyloric plane which is horizontal in position and placed midway between the top of the sternum and the top of the symphysis pubis, opposite the first lumbar vertebra. The pylorus is at least half an inch to the right of the middle line, and is readily recognised by the thickening of the muscular coats of the stomach to form the pyloric sphincter. Note that the opening looks almost directly backwards. The great difference in the levels of the two openings of the stomach is not always fully appreciated.

The lesser curvature connects the two apertures and affords attachment to the gastro-hepatic omentum.

The greater curvature is much more extensive than the preceding. It sweeps upwards over the fundus and gives attachment to the great omentum, and the gastro-splenic omentum.

The anterior surface of the stomach looks slightly upwards as well. A wide area of it next to the lesser curvature is in contact with the under surface of the left lobe of the liver. Of the remainder the portion next to the fundus is in contact with the disphragm and therefore under the shelter of the left costal margin; while the smaller area nearest to the pylorus is in contact with the anterior abdominal wall.

The posterior surface of the stomach looks also slightly downwards, and is in contact with a number of structures which are moulded round it to form what is known as the "stomach bed." Lying horizontally behind the stomach is the pancreas, with the splenic artery running along its upper border. Above the pancreas the stomach is in contact with the left kidney and suprarenal capsule, the inner surface of the spleen and a small area of the diaphragm just below the oesophageal opening. Below the pancreas the stomach is in apposition with the mesentery of the transverse colon, the bowel itself being moulded along the greater curvature.

The muscular coats of the stomach may be made out in a dissecting room subject, and are three in number. The external coat is composed of longitudinal fibres, while the intermediate layer consists of circular fibres and is much thickened in the region of the pylorus to form the pyloric sphincter. The internal muscular coat is rather scanty and is composed of fibres placed more or less obliquely. The other coats of the stomach are peritoneal, submucous and mucous.

THE DUODENUM.

The duodenum is the horse shoe shaped portion of small intestine which immediately succeeds the stomach. It is situated in the epigastric and umbilical regions. It is 10 inches long and is moulded round the head of the pancreas, the first part being above, the second part being to the right and the third part being below that viscus. On the left side of the second lumbar vertebra the duodenum ends by bending forwards upon itself to form the duodeno-jejunal flexure.

The first part of the duodenum is about two inches long, and is directed at first upwards, backwards and to the right from the pylorus. It then turns downwards into the second part. Its first inch is invested by the same two layers of peritoneum which enclose the stomach, so that the right free border of the gastro-hepatic omentum passes upwards from it to the liver. The second inch, and also the remainder of the duodenum are covered only in front by peritoneum. Above and in front of the first part of the duodenum is the under surface of the liver to which it bears a varying relationship. If the stomach be comparatively empty, the pylorus and the first inch of the duodenum are in contact with the quadrate lobe of the liver. If, however, the stomach be full,

the quadrate lobe of the liver is entirely occupied by its pyloric end, the first part of the duodenum being then pushed under the right lobe of the liver along with the beginning of the second part. Below, the first part of the duodenum is in relation to the head of the pancreas, while lying posteriorly are the common bile duct, the portal vein and the gastro-duodenal artery in that order from right to left. Another important superior relation of the first part of the duodenum is the foramen of Winslow with the hepatic artery.

The second or descending portion of the duodenum is three inches long and it ends on the right side of the third lumbar vertebra. In front it is crossed about the middle of its course by the transverse colon which at this point possesses no mesentery. Above this the duodenum is still in contact with the under surface of the liver, while below are coils of the small intestine. Behind the second part of the duodenum is the hilum of the right kidney with the right renal vessels and ureter; to the right is the hepatic flexure of the colon, and to the left the head of the pancreas. The common bile duct opens by a common orifice with the main duct of the pancreas on to the postero-internal aspect of the second part of the duodenum a little above its middle.

The third part of the duodenum sweeps first of all to the left, and then bends forwards upon itself to form the duodeno-jejunal flexure, as already noted. In front it is crossed from right to left by the superior mesenteric vein and artery and the root of the mesentery; while it is in contact posteriorly with the vena cava inferior, the abdominal aorta and the left psoas muscle from right to left. Above it lies the head of the pancreas.

The duodeno-jejunal flexure is situated on the left side of the second lumbar vertebra. To its right is the head of the pancreas, above it is the body of the pancreas and to its left are the lower end of the left kidney and the left ureter. The flexure is attached to the left crus of the diaphragm by an ill defined band of non-striated muscle, termed the suspensory muscle of the duodenum and mesentery. It prevents the root of the mesentery from being dragged downwards on the posterior abdominal wall by the weight of the intestines, so that defect or inefficiency of this structure produces the condition known as enteroptosis.

THE JEJUNUM AND ILEUM.

The remainder of the small intestine is composed of the jejunum and ileum and measures roughly about 20 feet of which 8 feet (or 2-5) are allotted to the jejunum and 12 feet (or 3-5) to the ileum. These are attached throughout their whole course to the posterior abdominal wall by means of the mesentery of the small intestines. The line of attachment of this is known as the root of the mesentery and is represented by an oblique line which crosses in front of the third part of the duodenum, the aorta, vena cava inferior and the right psoas muscle. The root of this mesentery is only about six inches long, but the other edge is reduplicated to an amazing degree, until it is able to afford attachment to the whole lengths of the jejunum and ileum.

DISSECTION.—Cut through the duodeno-jejunal flexure, and release the jejunum and ileum by severing their mesenteric attachment. Finally cut through the ileum an inch or two from the coecum. Select portions of gut from the upper end of the jejunum and from the lower end of the ileum. Slit these up along the line of their mesenteric attachments and wash away their contents at the tap in order to study their mucous membrane.

The division into jejunum and ileum is very arbitrary, as there is no definite line of demarcation between them. On examining their mucous membrane, however, it will be noted that the transverse folds (the valvulae conniventes) are larger and more crowded together in the jejunum. They become smaller and less numerous in the upper part of the ileum; while the lower part of the latter is usually quite free from them. It is advisable to slit up the duodenum at this stage in order to ascertain the fact that these transverse folds begin about 2 inches from the pylorus, and become more and more numerous as one approaches the jejunum.

The villi which are such a feature of the small intestine may be studied by means of a pocket lens. They give the fine velvety pile to the mucous membrane. They begin above at the same level as the transverse folds, they are largest and most numerous in the jejunum, and they end at the ileo-coecal valve.

The patches of Peyer are elongated masses of lymphoid tissue, placed with their long axes in the line of the gut, and always opposite the mesenteric attachment. They are confined mostly to the lower part of the ileum.

THE GREAT INTESTINE.

The great intestine is about 6 feet long and is composed of the coecum, ascending colon, hepatic flexure, transverse colon, splenic flexure, descending colon, iliac colon, pelvic colon, rectum and anal canal. The last two segments will be studied in the pelvis later. The great intestine is wider in calibre than the small intestine. The longitudinal muscular coat is collected into three bands or taeniae which by their tonicity throw the wall of the large intestine into sacculations. These taeniae are not seen on the walls of the rectum or anal canal. Another distinguishing feature of the great intestine is the presence of small peritoneal sacs of adipose tissue (appendices epiploicae) which are attached to its walls.

The coecum is situated in the right iliac region, its junction with the ileum being indicated on the surface of the anterior abdominal wall by the intersection of the intercristal and right mid inguinal planes. It is the blind 2½ inches of the great intestine, hence its name. It is covered entirely by peritoneum, and shows the retro-coecal fossa behind it. The coecum is placed obliquely immediately above the outer part of the right inguinal ligament. In front of it is the anterior abdominal wall, while posteriorly is the right iliopsoas muscle. The attachment of the vermiform appendix to the coecum is on its postero-internal aspect, directly below the ileo-coecal junction, and within half an inch of it. It can always be discovered by the fact that the three taeniae of the coecum con-

verge upon it. The mesentery of the appendix is a narrow V shaped structure one edge of which is occupied by the appendix and the other by the appendical artery. The appendix varies very much in length, but a fair average is about 3 or 4 inches. Its position also varies greatly, but it is usually directed inwards with a slight inclination up or down and it often hangs down over the brim of the pelvis.

The ileo-coccal valve is situated on the postero-internal aspect of the coccum at its junction with the ascending colon. On opening up the coecum it will be noted that the valve possesses a narrow upper and a wider lower flap, the ends of which are prolonged around the wall of the gut for some distance in the form of ridges termed retinaculae. The mechanism is obvious, since a distended coecum will render the retinaculae tense, and therefore tend to bring the flaps together and prevent reflux of material into the ileum.

The ascending colon ascends in the right lumbar region, and is not more than 6 or 8 inches long. It is covered in front and at the sides by peritoneum, but in rare cases may, like the descending colon, possess a mesentery. Posteriorly it rests upon the right iliacus and quadratus lumborum muscles, and the right psoas is directly to its inner side.

The hepatic flexure is situated in the right hypochondriac region. Its posterior surface which is bare of peritoneum is in contact with the lower part of the anterior surface of the right kidney. Above it is the under surface of the right lobe of the liver, while to its left side is the second part of the duodenum.

The transverse colon is usually the longest portion of the large intestine and is from 12 to 16 inches long. Its middle portion possesses a mesentery which permits of the bowel hanging downwards like a festoon in the umbilical region. At its right end, however, before it possesses a mesentery it lies in direct contact posteriorly with the second part of the duodenum, while its left end is moulded directly against the lower border of the pancreas. Above, the transverse colon is in relation to the greater curvature of the stomach, while below are the coils of the small intestine.

The splenic flexure is placed at a higher level than the hepatic flexure and is also situated deeper in the abdominal cavity. It lies in the left hypochondriac region, and is attached to the diaphragm by the phrenico-colic ligament. It is named from the fact that it is in contact with the inner surface of the spleen.

The descending colon runs downward in the left lumbar region and is about 6 or 8 inches long. It is covered in front and at the sides by peritoneum. Posteriorly it lies in contact with the lower end of the left kidney and the left quadratus lumborum muscle. The left psoas muscle lies directly to its inner side. The descending colon changes name into iliac colon after crossing the iliac crest.

The iliac colon lies in the left lumbar and left iliac regions, and extends from the iliac crest to the pelvic brim which it crosses opposite the sacro-iliac joint. From above downwards it crosses the left iliacus, the left psoas, and the left external iliac vessels at the pelvic brim. It is covered in front and at the sides by peritoneum, but its terminal portion frequently possesses a mesentery.

An important posterior relation in the male is represented by the left spermatic artery and vein. The latter may be compressed by a loaded bowel in chronic constipation, and produce varicocele.

The pelvic colon is defined as that portion of the great intestine which is attached to the posterior wall of the true pelvis by a V shaped mesentery. The outer limb of the V is the shorter and extends from the pelvic brim at the point of termination of the iliac colon upwards and inwards towards the sacral promontory. The inner limb of the V is almost vertical in direction, and extends downwards from the region of the sacral promontory to the front of the third piece of the sacrum in the middle line, where the pelvic colon ends and the rectum begins. The surgical importance of the peritoneal fossa in the angle of the V shaped mesentery has been previously emphasised. The pelvic colon possesses a considerable degree of latitude of movement, and usually rests in the recto-vesical fossa in the male or the recto-uterine fossa in the female, in the form of a U shaped loop of bowel lying on its side.

DISSECTION.—The colon has to be cut across at the pelvic brim, and the whole of the proximal portion removed by severing the blood vessels and peritoneal attachments. Slit up a segment of it, and after washing it at the tap, study the mucous membrane, and specially note the absence of villi and valvulae conniventes. Now pull the stomach upwards or downwards and define the relationships of the pancreas and spleen.

THE PANCREAS.

The pancreas is situated in the epigastric and left hypochondriac regions. It consists of a head, a neck, a body and a tail, and lies almost horizontally across the posterior abdominal wall.

The head is received into the concavity of the duodenum and lies in front of the first and second lumbar vertebrae. The first part of the duodenum is above it, the second part is to its right, the third part is below and the duodeno-jejunal flexure is to its left. The pyloric end of the stomach is in front, while posteriorly from right to left the common bile duct, the inferior vena cava and the abdominal aorta will be found. Note that the head of the pancreas is curved upon itself and presents a special relationship to the superior mesenteric vessels which pass downwards behind the neck of the pancreas and in front of the recurved portion of the head.

The neck of the pancreas is the slightly constricted portion connecting the head with the body. In front of it is the pyloric end of the stomach, while posteriorly are the superior mesenteric vessels, together with the point of junction of the superior mesenteric and splenic veins to form the portal vein.

The body of the pancreas presents anterior and posterior surfaces, and upper and lower borders.

The anterior surface of the body is slightly hollow and forms part of the "stomach bed." It is therefore in close relation to the posterior surface of the stomach.

The posterior surface of the body of the pancreas lies in front of the hilum and the middle third of the anterior surface of the left kidney, with the left renal vessels and ureter. A small portion of the left suprarenal gland is likewise behind it, as also the splenic vein, which is joined here by the inferior mesenteric vein.

The upper border of the body of the pancreas presents at its right end a small projection, the omental tubercle, which may be in contact with the gastro-hepatic omentum. Just above this projection is the origin of the coeliac axis artery, while its splenic branch pursues a very tortuous course along the remainder of the upper border in order to reach the spleen.

The lower border of the body of the pancreas affords attachment to the mesentery of the transverse colon, except towards the tail where the colon is directly moulded along it after losing its mesentery. The right end of the lower border rests upon the duodeno-jejunal flexure.

The tail reaches the inner surface of the spleen between the layers ofthe splenico-renal ligament and is in contact with the lower end of the hilum.

The main duct of the pancreas runs from left to right in the substance of the gland and opens into the second part of the duodenum along with the common bile duct, as previously noted. A minute accessory pancreatic duct may be found opening into the duodenum half an inch above the main duct.

THE SPLEEN.

The spleen lies in the left hypochondriac and epigastric regions. It is placed very obliquely, its upper end being much nearer the middle line of the body than its lower end. Its general direction corresponds to that of the ninth, tenth and eleventh left ribs, opposite which it lies, being separated, however, from these by the diaphragm and the lower margin of the left lung and the pleura. The spleen varies greatly in size, and presents for examination external and internal surfaces, anterior and posterior borders, and upper and lower ends.

The external surface is smooth and convex. It is entirely covered by peritoneum and is in contact with the diaphragm.

The internal surface presents a ridge which begins at the upper end of the spleen and runs downwards behind the hilum, opposite the lower end of which it fades away into a triangular area which is in contact with the splenic flexure of the colon, and is therefore known as the colic surface. The narrow area behind the ridge is in contact with the left kidney, while the larger hollow area in front is in relation to the fundus of the stomach. A fourth relationship of the inner surface of the spleen is the tail of the pancreas which is in contact with the lower end of the hilum. Two peritoneal folds, namely the gastro-splenic omentum and the splenico-renal ligament, are attached to the inner surface of the spleen.

The anterior border of the spleen is usually more convex than the posterior, and is moreover notched, while the other is smooth.

The upper end of the spleen almost touches the left suprarenal gland.

The lower end of the spleen rests upon the phrenico-colic ligament, and does not usually extend forwards beyond the midaxillary line. This is an important point clinically.

DISSECTION.—The stomach, duodenum, pancreas and spleen may now be removed together after severing their blood vessels. The next step is to remoe the liver by cutting the peritoneal ligaments, the structures at the transverse fissure, and the inferior vena cava both above and below.

THE LIVER.

The liver is the largest gland in the body. It possesses five lobes, five surfaces, five fissures and five ligaments. Morevover, five ribs are in relation to its right lateral surface. It weighs approximately fifty ounces in the male, and about five ounces less in the female. The liver is situated in the right hypochondriac, epigastric and left hypochondriac regions and may descend slightly into the right lumbar region as well. The liver therefore shows the greatest depth near its right lateral surface, while towards the left this rapidly diminishes until it becomes reduced to a sharp margin. The surfaces of the liver are anterior, superior, right lateral, inferior and posterior.

The anterior surface is somewhat triangular in outline, and is limited below by a sharp margin which separates it from the inferior surface. It is in contact with the diaphragm except over a V shaped area which is in contact with the anterior abdominal wall, and is therefore mapped off by the right and left costal margins. This V shaped area will be found to be bisected by the line of attachment of the falciform ligament which artificially maps off the anterior and superior surfaces into right and left lobes.

The superior surface is in contact with the under surface of the diaphragm and therefore presents two elevations which are in relation to the cupolae and to the bases of the lungs, with an intervening hollow which is in relation to the central tendon of the diaphragm and to the heart and pericardium.

The right lateral surface is slightly convex and is situated opposite the seventh, eighth, ninth, tenth and eleventh right ribs. It is separated from these, however, by the diaphragm, by the pleura as far as the tenth rib, and by the lung itself as far as the eighth rib. These are important data in reference to operations for hepatic abscess.

The inferior surface is limited in front by the sharp margin of the liver. It is traversed from before backwards by the longitudinal fissure which maps off the inferior and posterior surfaces of the liver into right and left lobes. The under surface of the left lobe presents a hollow area next to the sharp margin which is in relation to the anterior surface of the stomach. More posteriorly, however, is a slight prominence, the omental tubercle, which is in contact with the gastro-hepatic omentum.

The under surface of the right lobe is still further mapped off by the transverse fissure which passes to the right from the middle of the longitudinal fissure,

and divides the latter into anterior and posterior portions. The anterior portion contains the round ligament of the liver (the obliterated umbilical vein) and is therefore known as the umbilical fissure. It is often bridged over by hepatic tissue. The posterior portion of the longitudinal fissure contains the obliterated ductus venosus of the foetus, and is therefore usually known as the fissure for the ductus venosus. The umbilical fissure, the transverse fissure, the gall bladder and the sharp margin of the liver map off an area appropriately known as the quadrate lobe, which has been already shown to be in contact with the pylorus and the commencement of the duodenum. To the right of the gall bladder is an extensive portion of the under surface of the liver, on which three areas can usually be distinguished. The anterior area is in relation to the hepatic flexure of the colon, the larger posterior area is in contact with the right kidney, while the smallest area, which lies next to the neck of the gall bladder, is in relation to the first and second parts of the duodenum.

The posterior surface of the liver possesses some depth at its right extremity, but tails away into the sharp margin of the liver at its left extremity. It will be observed that a portion of the inferior vena cava is imbedded in the posterior surface of the liver, where it receives the hepatic veins. The triangular area to the right of this is known as the bare area of the liver, the base of which is formed by the inferior vena cava, while the upper and lower margins are formed by the upper and lower layers of the coronary ligament, which meet towards the right to form the right lateral ligament, the latter thus forming the apex of the area. The bare area of the liver is bound down to the diaphragm by areolar tissue with the exception of a small portion by the side of the inferior vena cava, close to the lower angle, which is in contact with the right suprarenal gland. The Spigelian lobe is the narrow tongue shaped area situated between the inferior vena cava and the fissure for the ductus venosus. It is covered by the peritoneum of the lesser sac, and is in contact with the diaphragm. The lower end of the Spigelian lobe becomes reduced to a narrow ridge of liver tissue which turns to the right between the transverse fissure and the inferior vena cava. This is known as the caudate lobe, and it is evident that it must constitute the upper boundary of the foramen of Winslow. To the left of the Spigelian lobe is a well defined notch into which fits the oesophagus immediately after it pierces the diaphragm.

The five "lobes" of the liver are—the right, left, quadrate, caudate and Spigelian. The five fissures of the liver are—the longitudinal, transverse, umbilical, the fissure for the ductus venosus and the fissure for the inferior vena cava. The five ligaments of the liver are—the falciform, left lateral, coronary, right lateral and the ligamentum teres, or round ligament. The round ligament is the obliterated umbilical vein of the foetus and passes from the umbilicus to be attached to the left extremity of the transverse fissure. It lies in the free border of the falciform ligament, the right and left layers of which connect the anterior and upper surfaces of the liver to the anterior abdominal wall and the diaphragm. The left layer of the falciform ligament sweeps to the left on the

upper surface of the liver and bends upon itself to form the left lateral ligament which connects the upper aspect of the left lobe of the liver to the diaphragm. The right layer of the falciform ligament, on the other hand, passes to the right and forms the upper layer of the coronary ligament which is reflected on to the under surface of the diaphragm. The lower layer of this ligament is simply the reflection of the peritoneum from the under surface of the liver on to the posterior abdominal wall. The meeting of the two layers of the coronary ligament to form the right lateral ligament has been already referred to.

THE GALL BLADDER AND BILE DUCTS.

The gall bladder is pear shaped and lies in its special fossa to the right of the quadrate lobe. The rounded end is known as the fundus and projects slightly beyond the sharp margin of the liver opposite the ninth right costal cartilage, while the narrow end or neck of the gall bladder is directed towards the right extremity of the transverse fissure where it becomes continuous with the cystic duct. The under surface and the fundus are the only portions of the gall bladder that are covered by peritoneum, the remainder being firmly bound down to the liver substance by connective tissue.

Hartman's pouch is the name given to a localised dilatation of the gall bladder close to its neck. It may overlie the cystic duct.

On opening up the interior and washing it out, it will be noticed that the mucous membrane exhibits honeycomb like depressions. An examination of the interior of the cystic duct at the same time will show that its mucous membrane is thrown up in the form of a spiral valve. The cystic duct makes an S shaped bend, and then unites with the common hepatic duct to form the common bile duct, the former being produced by the union of the right and left hepatic ducts which emerge from the two extremities of the transverse fissure in front of the right and left branches of the hepatic artery and portal vein. The common bile duct is about 3 inches long, and is directed downwards in the right free border of the gastrohepatic omentum, to the right of the hepatic artery, and in front of the portal vein. It then passes behind the first part of the duodenum, and after lying in the groove between the head of the pancreas and the second part of the duodenum, opens into the latter on its postero-internal aspect by a common orifice with the chief duct of the pancreas. This opening is on the summit of a small projection of mucous membrane known as the bile papilla. Just inside this orifice is a slight dilatation known as the ampulla.

DISSECTION.—The adipose tissue surrounding the kidneys and suprarenal glands has now to be removed, and these viscera prepared for examination. At the same time trace each ureter down to the brim of the pelvis.

THE KIDNEYS.

Each kidney has the characteristic reniform shape, the hilum being placed on the inner border of each. The left kidney is situated in the epigastric and left hypochondriac regions, while the right in addition descends about half an inch into the right lumbar and umbilical regions. The kidneys are placed opposite the twelfth dorsal and first three lumbar vertebrae. The right kidney is in front of the twelfth rib; while the left, owing to its being placed slightly higher, comes to lie in front of the eleventh and twelfth ribs.

The posterior surface of each kidney is in relation in its upper third to the diaphragm which separates it from the pleura, while the lower two thirds in each case are in contact from without inwards with the transversalis, quadratus lumborum and psoas muscles, the area for the quadratus being the widest of the three. Passing outwards behind each kidney are the last dorsal, ilio-hypogastric and ilio-inguinal nerves, named in that order from above downwards. A close examination of the posterior surfaces of the kidneys further shows that the tips of the upper lumbar transverse processes frequently leave impressions upon them.

The anterior surface of the right kidney exhibits a curved area next to the hilum which is in contact with the second part of the duodenum. The upper two thirds of the remainder are in contact with the liver, and the lower third with the hepatic flexure of the colon. The only one of these areas that is covered with peritoneum is the liver area, though a small portion close to the lower end may be covered by the peritoneum of the greater sac.

The anterior surface of the left kidney is crossed in its middle third by the body of the pancreas together with the splenic vessels. The upper third is in relation internally to the posterior surface of the stomach and externally to the inner surface of the spleen, while the lower third is in contact externally with the commencement of the descending colon, and is covered more internally by the peritoneum of the greater sac. The other two peritoneal areas are those for the stomach and spleen; and these are separated from each other by the line of attachment of the splenico-renal ligament.

The upper end of each kidney is surmounted by the suprarenal gland.

The lower ends of the kidneys are further apart than the upper ends, owing to the fact that they are pushed outwards by the sloping outer borders of the psoas muscles. The lower end of the right kidney is one inch above the iliac crest while the lower end of the left is one and a half inches from the iliac crest.

The hilum of each kidney presents the renal vein, renal artery, and the ureter, named in that order from before backwards. As the ureter is directed downwards, the side to which a detached kidney belongs can be readily determined.

THE URETERS.

The ureter is 10 inches long, the upper half being in the abdomen and the lower half in the pelvis. After emerging from the posterior aspect of the hilum

the ureter is directed almost vertically downwards upon the psoas muscle, and enters the pelvis by crossing in front of the bifurcation of the common iliac artery. Anteriorly each ureter is covered by the peritoneum of the greater sac and is crossed by the spermatic or ovarian vessels (which supply minute arterial twigs to its middle segment). Note in addition that the upper end of the right ureter lies behind the duodenum, while the upper end of the left is situated behind the body of the pancreas. The right ureter is crossed anteriorly by the root of the mesentery of the small intestines, while the left ureter has the colon lying in front of it at the pelvic brim.

DISSECTION.—Split the kidney so as to study the upper end of the ureter, which widens out in the hilum to form the pelvis of the ureter. This exhibits a series of recesses between the apices of the renal pyramids, termed calices.

THE SUPRARENAL GLANDS.

Each suprarenal gland is a small flattened structure of semilunar outline, perched on the upper end and inner border of the corresponding kidney. Posteriorly each rests upon the corresponding crus of the diaphragm, while to its inner side is the semilunar ganglion of the solar plexus.

The anterior relations of the right suprarenal gland are the bare area of the liver and perhaps a small portion of the duodenum.

The anterior relations of the left suprarenal gland are the posterior surface of the stomach and the posterior aspect of the body of the pancreas.

THE ABDOMINAL AORTA.

DISSECTION.—The abdominal aorta must now be cleaned and its paired branches defined. It will be noted that the main vessel as well as its branches are invested in a tough plexus of sympathetic nerves, while a few lymph glands will be found on each side and in front of the aorta.

The abdominal aorta begins in the middle line of the body in front of the lower border of the twelfth dorsal vertebra. Its course is downwards and slightly to the left, and it ends on the left side of the body of the fourth lumbar vertebra by dividing into the right and left common iliac arteries. This bifurcation is indicated on the surface by a point half an inch below and to the left of the umbilicus (the latter is situated opposite the disc between the third and fourth lumbar vertebrae).

The posterior relations of the abdominal aorta are the upper four lumbar vertebrae with their anterior common ligaments, and the four left lumbar veins.

The immediate anterior relations are arranged in pairs from above downwards as follows:

(1) The peritoneum on the posterior wall of the lesser sac, and the coeliac sympathetic plexus which surrounds the coeliac axis artery;

(2) The pancreas and the splenic vein;

(3) The third part of the duodenum and the left renal vein;

(4) The peritoneum on the posterior wall of the greater sac and the aortic sympathetic plexus.

The more remote anterior relations are the liver, gastro-hepatic omentum, the stomach, the great omentum, the transverse colon, the mesentery of the transverse colon, the mesentery of the small intestines, and the small intestine itself.

By the right side of the abdominal aorta in the lower portion of its course is the inferior vena cava, which separates it from the right sympathetic cord, while to its left side is the left sympathetic chain. On each side higher up is the corresponding crus of the diaphragm, and between the vessel and the right crus the receptaculum chyli with the commencement of the thoracic duct, and the vena azygos major will be found.

The branches of the abdominal aorta from above downwards are as follows—

(1) Inferior phrenic (paired),
(2) Coeliac axis (unpaired),
(3) Middle capsular (paired),
(4) Superior mesenteric (unpaired),
(5) Renal (paired),
(6) Spermatic or ovarian (paired),
(7) Inferior mesenteric (unpaired),
(8) The four pairs of lumbar arteries are given off in series all the way down, but are conveniently mentioned here;
(9) The middle sacral (unpaired),
(10) The terminal common iliac (paired).

It may thus be noted that the paired and unpaired branches arise alternately except at one point.

Each inferior phrenic artery sweeps outwards upon the corresponding crus of the diaphragm, the right passing behind the inferior vena cava and the left behind the oesophagus. Each divides into inner and outer branches of which the former anastomose with one another round the central tendon of the diaphragm, while the outer branches proceed towards the lateral margins of the diaphragm and after supplying it, end by anastomosing with the intercostal and musculo-phrenic arteries. Each inferior phrenic artery also furnishes the superior capsular artery to the suprarenal gland.

The coeliac axis artery has been already described.

The middle capsular arteries arise opposite the suprarenal glands and constitute part of their arterial supply.

The superior mesenteric artery has been previously described.

The renal arteries are comparatively large vessels. Each passes outwards transversely in order to enter the hilum of the corresponding kidney, where its position has been previously seen to be intermediate between the renal vein and the ureter. Each gives off an inferior capsular artery to the suprarenal gland.

The spermatic or ovarian vessels arise immediately below the renal arteries and run downwards and outwards in front of the ureter and the psoas

muscle, the vessels of the right side having to cross, in addition, the inferior vena cava. Their upper ends are situated behind the third part of the duodenum, but for the remainder of their course they are covered merely by the peritoneum of the posterior abdominal wall.

The ovarian artery enters the pelvis by crossing the external iliac artery close to its origin and therefore just in front of the ureter and immediately behind the colon. Its further course in the female pelvis will be studied later.

The spermatic artery is continued downwards on the psoas muscle in order to reach the abdominal inguinal ring, where it joins the other constituents of the spermatic cord. At the latter point the vessel is situated immediately in front of the termination of the external iliac artery, having previously been an external relation of this artery for some distance.

In the lower portion of their course the spermatic vessels are still covered anteriorly by the peritoneum of the posterior abdominal wall, the artery and vein of the left side being crossed in addition by the iliac colon. The surgical importance of the latter relationship in reference to varicocele has been previously emphasised.

The inferior mesenteric artery has been already described.

The four pairs of lumbar arteries arise in regular series from the abdominal aorta all the way down. They pass outwards upon the bodies of the upper four lumbar vertebrae, and under cover of the corresponding psoas muscle, being protected during the contraction of the latter by special tendinous arches. It will be noted that the upper three arteries pass also under the quadratus lumborum; but the fourth artery, being situated below the level of the iliac crest, runs outwards upon the iliacus muscle, and supplies its upper part. The upper three arteries after supplying the psoas and quadratus lumborum, are continued forwards between the abdominal muscles, and after supplying these, end by anastomosing with the lower intercostal arteries and the subcostal artery.

The middle sacral artery is very small, and arises from the angle of bifurcation of the abdominal aorta. It runs downwards upon the fifth lumbar vertebra and enters the pelvis in front of the sacral promontory. It is continued downwards in front of the middle line of the sacrum and ends in the coccygeal body, the latter being a peculiar mass of blood vessels placed in front of the coccyx. The middle sacral artery anastomoses with the lateral sacral arteries after supplying the tissues in front of the sacrum.

THE COMMON ILIAC ARTERIES.

The common iliac arteries are the terminal branches of the abdominal aorta and arise on the left side of the fourth lumbar vertebra. They diverge on the anterior aspect of the fifth lumbar vertebra and end opposite the lumbo-sacral disc by dividing into the external and internal iliac arteries. In front they are covered by the peritoneum of the posterior abdominal wall and by many sympathetic nerve fibres which are streaming downwards to join the pelvic plexuses, while the point of bifurcation of each is crossed anteriorly by the

corresponding ureter. The left common iliac artery possesses an extra anterior relation in the form of the inferior mesenteric vessels. Note that the left common iliac vein lies to the inner side of its artery, and then passes behind the right common iliac artery to join the right common iliac vein which lies to the right side of its artery. The external and internal iliac arteries are the only branches of the common iliac vessels. Of these the internal iliac artery will be studied later in the pelvis.

THE EXTERNAL ILIAC ARTERIES.

The external iliac artery begins opposite the lumbo-sacral disc as the larger terminal branch of the common iliac. Its course follows approximately the line of the pelvic brim, and it terminates behind the inguinal ligament at a point midway between the anterior superior iliac spine and the symphysis by changing name into femoral. At first the external iliac artery lies along the inner border of the psoas, finally coming to lie in front of this muscle and the fascia iliaca. Anteriorly the artery is covered throughout almost its whole course by the peritoneum as this sweeps downwards into the pelvis over the pelvic brim. In addition the artery is crossed at its very origin by the ureter, just below this, in the female, by the ovarian vessels and immediately beyond this again, on the left side only, by the colon, as this sweeps over the pelvic brim. At its very termination the artery is crossed by the deep circumflex iliac vein in both sexes, and in the female by the round ligament of the uterus as it enters the abdominal inguinal ring. To the outer side of the external iliac artery are the genito-femoral nerve, and in addition, in the male, the spermatic vessels which meet the ductus deferens at the abdominal inguinal ring immediately in front of the termination of the artery. It will be noticed that the external iliac vein is situated on the postero-internal aspect of the artery.

The two branches of the external iliac artery namely, the deep epigastric and the deep circumflex iliac have been already studied in the anterior abdominal wall.

THE PORTAL SYSTEM.

The blood from the coeliac axis, the superior mesenteric and the inferior mesenteric arteries that goes to supply the walls of the alimentary canal, has to pass through the capillaries of the liver and the series of veins that collects this blood constitutes the portal system. Thus the portal circulation differs from the systemic circulation in this respect—that its blood has to pass through two sets of capillaries namely, those of the gastro-intestinal canal and those of the liver, before being returned to the heart. It is important to note that the veins of the portal system possess no valves a factor that has a predisposing influence upon the development of haemorrhoids.

The portal vein is formed behind the neck of the pancreas by the union of the superior mesenteric and splenic veins. It is directed upwards behind the first part of the duodenum, and enters the right free border of the gastro-hepatic

omentum, where it lies posterior to the hepatic artery and common bile duct. At the transverse fissure of the liver the portal vein ends by dividing into (larger) right and (smaller) left terminal branches which enter the liver at the extremities of this fissure.

The portal vein is joined by the pyloric vein and the coronary vein from the stomach and the lower end of the oesophagus, while its right branch receives the cystic vein from the gall bladder.

The superior mesenteric vein receives the veins corresponding to the branches of the artery, and in addition the superior pancreatico-duodenal and right gastro-epiploic veins.

The inferior mesenteric vein receives the blood corresponding to the artery, and its venules in the wall of the rectum communicate with those of the middle and inferior haemorrhoidal veins which drain into the systemic circulation. There is apt to be a varicose condition of the venules at the junction of these two systems in the rectal wall, thus producing haemorrhoids or piles.

The blood of the portal system, after traversing the liver, is re-collected into the hepatic veins which empty into the vena cava inferior, as it lies in the fissure on the posterior aspect of the liver.

THE INFERIOR VENA CAVA.

The inferior vena cava begins on the right side of the fifth lumbar vertebra by the union of the right and left common iliac veins. It runs upwards upon the right side of the abdominal aorta, but becomes separated from this higher up by the right crus of the diaphragm. Towards the end of its course it lies in the vena caval fissure on the posterior surface of the liver and leaves the abdomen by passing through the vena caval opening in the diaphragm in order to enter the right auricle of the heart. From below upwards it rests upon the lumbar vertebrae and the diaphragm. The right renal artery and the right semilunar ganglion of the solar plexus also lie behind it. Anteriorly from below upwards it is in relation to the peritoneum of the posterior abdominal wall, the third part of the duodenum, the head of the pancreas, the foramen of Winslow and the posterior surface of the liver. It is also crossed in front by the root of the mesentery of the small intestines.

The tributaries of the vena cava inferior are—

(1) The inferior phrenic veins,
(2) The hepatic veins,
(3) The right capsular vein,
(4) The renal veins,
(5) The right spermatic or ovarian vein,
(6) Four pairs of lumbar veins,
(7) The veins of formation.

Note that the left capsular vein and the left spermatic or ovarian vein join the left renal vein, while the middle sacral vein enters the left common iliac vein.

THE MUSCLES AND FASCIAE ON THE POSTERIOR ABDOMINAL WALL.

DISSECTION.—Remove the kidneys and clean the fascia covering the psoas, iliacus and quadratus lumborum muscles, and also that lining the under surface of the diaphragm.

The fascia iliaca is the name given to the fascia covering the psoas and iliacus muscles, which forms one continuous sheet. Internally it is attached to the bodies of the lumbar vertebrae except opposite the lumbar vessels, and lower down to the pelvic brim. Externally from above downwards it is attached to the fascia covering the quadratus lumborum and to the inner lip of the iliac crest. Below, it is attached along the inguinal ligament except opposite the femoral vessels, where it is prolonged downwards into the thigh as the posterior wall of the femoral sheath. Above, it is quite narrow, as it has merely to cover the psoas, and its upper border is called the internal arcuate ligament which passes from the transverse process of the first lumbar vertebra to the side of the body of the second, and gives part origin to the diaphragm.

The fascia covering the quadratus lumborum is really the anterior lamella of the lumbar fascia. Internally it is attached to the fascia iliaca, below to the iliac crest and ilio-lumbar ligament, and externally to the fascia transversalis. Its upper border forms the external arcuate ligament which passes from the twelfth rib to the transverse process of the first lumbar vertebra and affords part origin to the diaphragm.

DISSECTION.—These layers of fascia may now be removed in order to define the attachments of the psoas and quadratus lumborum muscles. In so doing take care not to damage the branches of the lumbar plexus which appear at the outer border of the psoas.

The psoas muscle arises from the intervertebral discs and adjacent margins of the bodies of the vertebrae, from the twelfth dorsal to the fifth lumbar inclusive, from the transverse processes of the lumbar vertebrae and from the fibrous arches thrown over the lumbar arteries. The muscle rapidly narrows as it passes downwards along the pelvic brim. It enters the thigh behind the inguinal ligament and is joined by the fibres of the iliacus to form the ilio-psoas which is inserted into the small trochanter of the femur and slightly into the bone below this. Its nerve supply is from the lumbar plexus and its action is to flex the thigh, and rotate it inwards. The psoas parvus is the name given to a separate tendon sometimes seen on the front of the muscle.

The iliacus muscle arises from the upper two thirds or so of the iliac fossa, and its fibres converge in a downward direction to obtain insertion into the psoas tendon. Its nerve supply is from the femoral, and its action is the same as that of the psoas.

The quadratus lumborum muscle takes origin from the posterior third of the iliac crest, from the ilio-lumbar ligament and from the transverse processes of the lumbar vertebrae. Its insertion is into the inner portion of the lower

border of the twelfth rib and into certain of the lumbar transverse processes. Its nerve supply is derived from the lumbar plexus, and its action is to assist the erector spinae group in bending the trunk over to the same side. It also steadies the ribs in respiration.

THE DIAPHRAGM.

The diaphragm arises posteriorly by the right and left crura of which the right arises from the first three lumbar vertebrae and the left from the first two. More externally the muscle arises on each side from the internal and external arcuate ligaments and from the deep aspects of the lower six costal cartilages, the latter fibres interdigitating with those of the transversalis. In front the muscle takes origin by two slips from the posterior aspect of the ensiform cartilage. The muscle fibres arch inwards to obtain insertion into the central tendon, the upward bulging on each side of which constitutes the right and left cupolae. The central tendon is trefoil in shape, the right lobe being the largest while the anterior or middle lobe is also intermediate in size. The diaphragm is supplied by the two phrenic nerves, as already shown, and also by the lower intercostal nerves. It is the great muscle of inspiration, and is therefore next to the heart the most important muscle in the body.

The diaphragm exhibits three main openings. The aortic opening is formed by the union of the two crura and is situated in front of the twelfth dorsal vertebra. It transmits the aorta, thoracic duct and vena azygos major in that order from left to right. The oesophageal opening is between the aortic opening and the left lobe of the central tendon, and is situated opposite the tenth dorsal vertebra. In addition to the oesophagus it transmits the right and left vagus nerves, the former being behind and the latter in front of the oesophagus. The inferior vena caval opening is situated in the right lobe of the central tendon, opposite the eighth dorsal vertebra, and transmits, in addition, one or two twigs from the right phrenic nerve. Note further that each crus is pierced by three splanchnic nerves, and the left in addition by the vena azygos minor. The sympathetic cord passes behind the internal arcuate ligament. The superior epigastric artery passes through between the sternal and costal attachments of the diaphragm, while the musculo-phrenic artery pierces it opposite the eighth costal cartilage.

THE LUMBAR PLEXUS.

DISSECTION.—The psoas muscle will require to be dissected away in order to expose the lumbar plexus which is imbedded in its substance. Secure first of all the ilio-hypogastric, ilio-inguinal, external cutaneous, and femoral branches which appear at its outer border, the obturator branch which appears at its inner border, and the genito-femoral nerve which pierces the muscle anteriorly. After these have been identified remove the psoas bit by bit until the whole plexus is exposed.

The lumbar plexus is formed by the anterior divisions of the first four lumbar nerves. It may be noted that the first usually receives a small communicating twig from the twelfth dorsal nerve, while the fourth sends downwards a branch to the fifth lumbar nerve to form the lumbo-sacral cord. The first lumbar nerve gives off the ilio-hypogastric and ilio-inguinal nerves; while the second, third and fourth each divides into anterior and posterior branches, of which the three anterior unite to form the obturator nerve, and the three posterior branches join to form the femoral nerve. The external cutaneous nerve of the thigh arises from the posterior branches of the second and third nerves, and the genito-femoral takes origin from the first and second nerves. In addition, the lumbar plexus furnishes the nerves of supply to the psoas and quadratus lumborum muscles.

The ilio-hypogastric and ilio-inguinal nerves emerge from under cover of the outer border of the psoas, cross in front of the quadratus lumborum and pierce the transversalis in order to run forward between this muscle and the internal oblique. Their further distribution in the anterior abdominal wall has been studied previously. The ilio-hypogastric nerve is the uppermost of the two.

The external cutaneous nerve after emerging from under cover of the outer border of the psoas, crosses the iliacus in order to enter the thigh under cover of the outer end of the inguinal ligament. Its further course in the thigh has been previously studied.

The femoral nerve lies in the groove between the psoas and the iliacus and enters the thigh behind the inguinal ligament and to the outer side of the femoral artery. In this part of its course it gives off one branch only, namely to the iliacus muscle.

The obturator nerve runs downwards under cover of the inner border of the psoas, and gradually sinks into the pelvis, along the outer wall of which it passes in order to reach the upper end of the obturator foramen, through which it enters the thigh.

The genito-femoral nerve is the only branch of the lumbar plexus that pierces the fascia iliaca. All the others remain behind this fascial sheet. This nerve runs downwards to the outer side of the external iliac artery. Its genital branch passes through the abdominal inguinal ring in order to supply the cremaster muscle, while the femoral branch enters the thigh with the femoral artery in the outermost compartment of the femoral sheath. Its distribution in the thigh has been previously studied.

THE SOLAR PLEXUS.

The solar plexus of sympathetic nerves has been removed for the most part, but the two semilunar ganglia which constitute the nucleus of the plexus may now be studied. Each of these is an irregular ganglionic mass which lies on the corresponding crus of the diaphragm, just external to the coeliac axis artery. Each lateral half of the plexus is joined by the three splanchnic nerves which will be found piercing the crura of the diaphragm.

The distribution of the solar plexus closely follows the branches of the abdominal aorta. For example the diaphragmatic plexuses follow the inferior phrenic arteries, the coeliac plexus divides into coronary, splenic and hepatic portions, the suprarenal plexuses accompany the capsular arteries to the suprarenal glands, the renal plexuses follow the renal arteries into the kidneys and the superior mesenteric plexus is distributed along the corresponding artery to the intestinal tract. The remainder of the solar plexus is prolonged downwards on the aorta as the aortic plexus which in its turn furnishes the spermatic or ovarian plexuses to the testes or ovaries, the inferior mesenteric offshoot along the corresponding artery, and is then prolonged downwards into the pelvis over the common iliac arteries to form the pelvic plexuses.

THE ABDOMINAL LYMPH GLANDS.

The main chains of abdominal lymphatic glands are three in number, one on each side of the abdominal aorta (known as the lumbar glands) and one in front of that vessel. The lumbar glands receive the lymph drainage from the diaphragm, the suprarenal glands, the kidneys, the abdominal wall, the testes or ovaries, and from the glands along the iliac arteries, which in their turn drain the lymph from the pelvis and lower limbs. The glands in front of the abdominal aorta are grouped round the three great unpaired arteries, and receive the lymph drainage from the viscera supplied by these. Subsidiary chains are found lying along the branches of these arteries, of which some possess considerable clinical importance. For example those arranged along the curvatures of the stomach and between the layers of the gastro-hepatic omentum are apt to be affected in pyloric carcinoma.

The superior mesenteric glands which are situated along this artery and its branches between the layers of the mesentery of the small intestines are very numerous, at least 100 having been counted. Similarly the inferior mesenteric glands receive the lymph drainage from the segment of gut supplied by the artery. The efferent lymph vessels from the three great chains of abdominal glands drain into the receptaculum chyli.

The receptaculum chyli is a thin walled structure which lies in front of the second lumbar vertebra, between the abdominal aorta and the right crus of the diaphragm. Its upper end is drained by the thoracic duct which enters the thorax through the aortic opening.

The vena azygos major and vena azygos minor begin in the abdomen as minute veins connecting the lumbar veins vertically. The vena azygos major enters the thorax through the aortic opening, and the vena azygos minor by piercing the left crus of the diaphragm.

THE MALE PERINEUM.

DISSECTION.—Raise the pelvic end of the trunk upon a block and remove the remains of the skin from the perineum after tying the penis and the remains of the scrotum upwards out of the way. Note that the perineum is the outlet of the pelvis. It is therefore essential to examine its boundaries in the skeleton. In front it is limited by the symphysis pubis, behind by the tip of the coccyx, while on each side from before backwards are the descending ramus of the pubis, the ramus and tuberosity of the ischium, and the sacro-tuberous ligament. An imaginary transverse line between the anterior ends of the ischial tuberosities maps off the anterior or urethral triangle from the posterior or rectal triangle. Commence with the latter and under the supervision of the demonstrator dissect out the contents of the ischio-rectal fossa, which lies on each side of the rectum.

THE ISCHIO-RECTAL FOSSA.

The ischio-rectal fossa is the deep recess situated between the rectum and the inner aspect of the ischium. It possesses four walls, a linear apex, and a base, and is therefore wedge shaped. Each wall contains a muscle and a membranous structure. The outer wall is vertical in direction and is formed by the obturator internus muscle, covered by the obturator fascie. In contrast to this, the inner wall is markedly sloping, and is composed of the levator ani muscle covered by the anal fascia. The ill defined anterior wall consists of the base of the triangular ligament, resting upon which is the transversus perinei muscle. The posterior wall is represented by the sacro-tuberous ligament resting upon which is the lower border of the gluteus maximus. The linear apex of the ischio-rectal fossa is formed by the fusion of the obturator fascia with the anal fascia, and the base is formed by the skin.

The internal pudendal vessels and nerve will be found running forwards in a tunnel in the obturator fascia, termed Alcock's canal. In this part of their course they give off the inferior haemorrhoidal and the superficial perineal vessels and nerves. The contents of the fossa are therefore as follows—

(1) Crossing the space transversely from the outer to the inner wall are the inferior haemorrhoidal vessels and nerve;

(2) In the anterior portion of the fossa are the superficial perineal vessels and nerves, which should be traced forwards to the perineum and scrotum.

(3) In the posterior portion of the space will be found the perforating cutaneous nerve and the perineal branch of the fourth sacral nerve which pierce the levator ani muscle by the side of the coccyx. The former winds round the lower border of the gluteus maximus to supply a small area of skin over it, while the latter supplies the external sphincter of the anus.

(4) The most important structure occupying the fossa is the plug of adipose tissue which fills it completely, and is apt to be the site of an ischiorectal abscess.

The external sphincter is difficult to define owing to the paleness of its fibres. It arises posteriorly from the tip of the coccyx and anteriorly from the central point of the perineum. From these two points the fibres pass to form an interlacing system round the anal orifice. Its nerve supply is from the two inferior haemorrhoidal nerves and the two perineal branches of the fourth sacral nerves.

THE URETHRAL TRIANGLE.

The superficial perineal vessels and nerves have been already found to supply the skin over this triangle, together with the long pudendal nerve from the posterior cutaneous nerve of the thigh. The layer of fascia which covers the superficial perineal muscles is known as the fascia of Colles. This is attached posteriorly to the base of the triangular ligament, on each side to the rami of the ischium and pubis, while anteriorly it sweeps on each side of the root of the penis to become continuous with the membranous layer of the superficial fascia on the lower part of the anterior abdominal wall. This explains why an extravasation of urine due to rupture of the anterior urethra is forced upwards on to the anterior abdominal wall.

The superficial perineal muscles when defined and cleaned will be found to be

(1) The ischio-cavernosus lying along the pubic and ischial rami;

(2) The bulbo-cavernosus or ejaculator urinae in the middle line;

(3) The transversus perinei, which is directed transversely and meets its fellow, the sphincter ani externus, the ejaculator urinae and the levator ani in a tendinous intersection termed the central point of the perineum.

The ischio-cavernosus covers the crus of the penis. It arises posteriorly from the inner aspect of the ischial tuberosity and spreads out into a tendinous expansion which is inserted into the crus of the penis. Its nerve supply is from the internal pudendal.

The ejaculator urinae covers the bulb of the corpus spongiosum of the penis. It arises posteriorly from the central point of the perineum and from a mesial intersection or raphe on the superficial aspect of the bulb. The fibres are inserted into the triangular ligament, but those most anterior encircle the bulb and the junction of the roots of the penis. It is innervated by the internal pudendal nerve.

The transversus perinei muscles rest upon the base of the triangular ligament. Each arises from the inner aspect of the ischial tuberosity and they meet in the central point of the perineum. They are supplied by the internal pudendal nerves.

DISSECTION.—Remove the perineal muscles carefully, in order to expose the root of the penis and the superficial surface of the triangular ligament. Dissect out at this stage the dorsal vein, the dorsal arteries and dorsal nerves on the dorsum of the penis and then remove the skin from this in order to study

the corpora cavernosa which constitute its dorsal portion and the corpus spongiosum which forms its ventral portion.

The corpora cavernosa are two cylindrical masses of erectile tissue enclosed in strong fibrous capsules, which blend with one another in the middle line to form the dorsal portion of the penis. Their anterior ends give attachment to the glans penis while posteriorly they diverge to form the two crura which are firmly attached along the rami of the pubes.

The corpus spongiosum, the bulb and the glans penis form one continuous mass of erectile tissue which is tunnelled by the urethra. The bulb or posterior end is firmly attached to the surface of the triangular ligament and receives the urethra which pierces this ligament. The posterior end of the bulb is notched to show its bilateral character, embryologically speaking. The corpus spongiosum is firmly attached to the ventral aspects of the corpora cavernosa.

The dorsal ligament of the penis is the name given to an ill defined band of fibrous tissue connecting the dorsal aspect of the penis to the ligaments in front of the symphysis pubis.

DISSECTION.—Carefully detach the crura of the penis from the pubic rami and the bulb from the surface of the triangular ligament. The urethra will have to be severed as also the pudendal vessels and nerve as they pierce the ligament under cover of the crura.

The triangular ligament is the superficial sheath of the compressor urethrae muscle specially thickened to afford support to the root of the penis. It is pierced about its centre by the urethra, on each side of which emerges the artery to the bulb. It is also pierced on each side under cover of the anterior end of the crus by the internal pudendal vessels and nerve. Note further that the dorsal vein of the penis passes between its truncated apex and the symphysis pubis.

DISSECTION.—Great difficulty will be found in exposing the compressor urethrae owing to the scanty character of the muscle. Note, however, that it possesses an ill-defined sheath on its deep aspect also. This is classed as parietal pelvic fascia, but is sometimes known as the deep layer of the triangular ligament. If one accepts this description it may be noted that the following structures lie between the two layers of the triangular ligament—

(1) The compressor urethrae muscle surrounding the membranous portion of the urethra,

(2) Cowper's glands,

(3) The internal pudendal vessels with the arteries to the bulb,

(4) The internal pudendal nerves. Note that the dorsal vein of the penis does not lie within the two layers of the triangular ligament as it passes between them and the symphysis pubis.

The compressor urethrae muscle arises on each side from the deep aspects of the descending rami of the pubes and forms an interlacing system of fibres round the membranous portion of the urethra, upon which it appears to exert a sphincteric action. It is innervated by the internal pudendal nerves.

Cowper's glands are minute pea-like structures lying on each side of the urethra, into which their ducts discharge their mucous secretion.

The internal pudendal artery after leaving the gluteal region by entering the lesser sciatic foramen runs forwards in Alcock's canal in the outer wall of the ischio-rectal fossa. It is then continued forwards along the line of the pubic ramus between the two layers of the triangular ligament the superficial layer of which it pierces under cover of the anterior end of the crus penis. Immediately after doing so the artery terminates by dividing into the dorsal artery of the penis and the artery to the corpus cavernosum. Its other branches are the inferior haemorrhoidal artery, the perineal arteries and the artery to the bulb.

The inferior haemorrhoidal artery arises in Alcock's canal and runs transversely inwards in the ischio-rectal fossa to supply the lower end of the rectum and the anal canal. It anastomoses with the middle haemorrhoidal artery.

The perineal arteries are small branches which arise in Alcock's canal and after traversing the anterior part of the ischio-rectal fossa, supply the superficial perineal muscles and then end as cutaneous branches to the skin of the perineum and scrotum.

The artery to the bulb arises between the layers of the triangular ligament, and runs transversely inwards. After supplying Cowper's gland it pierces the superficial layer of the triangular ligament in order to reach the bulb.

The internal pudendal nerve accompanies the vessels in Alcock's canal, and also between the layers of the triangular ligament, where it lies next to the pubic ramus. It pierces the superficial layer of the triangular ligament along with the artery and ends like it by dividing into the dorsal nerve of the penis and the nerve to the corpus cavernosum. Its other branches are the inferior haemorrhoidal nerve and the perineal branches.

The inferior haemorrhoidal nerve arises in Alcock's canal and traverses the ischio-rectal fossa along with the artery. It ends by supplying the external sphincter and the skin round the anus.

The perineal branches spring from the nerve in Alcock's canal and run forward in the anterior portion of the ischio-rectal fossa. They supply the ischio-cavernosus, the ejaculator urinae, the transversus perinei and the compressor urethrae muscles, and also twigs to the bulb, and are then continued as two superficial perineal branches which supply the skin of the perineum and scrotum.

On the dorsum of the penis the dorsal vein lies in the middle. On each side of this is the corresponding artery and on each side of this again is the dorsal nerve.

THE FEMALE PERINEUM.

The dissection of the ischio-rectal fossae will be found to be the same as in the male.

Examine next the female external genitalia or pudenda. The most external folds guarding the uro-genital orifices are the labia majora which meet in front of the pubes to form the mons veneris. To the inner side of these are the smaller labia minora each of which when traced forwards divides into two folds to enclose the clitoris which is the homologue of the penis. The upper fold meets its

fellow of the opposite side to form the prepuce of the clitoris, while the lower folds will be found to blend with the under aspect of the clitoris, thus forming its fraenulum.

The vaginal orifice is guarded in the virgin by a fold of mucous membrane termed the hymen. In women who have borne children this gets broken up into small projections termed the carunculae myrtiformes. The triangular area in front of the vaginal orifice is called the vestibule; at the base of which, that is to say immediately in front of the vaginal opening, is the orifice of the female urethra.

DISSECTION.—Stitch up the vaginal orifice and remove the skin from the urethral triangle. Note that no fascia of Colles can be distinguished in the female. The superficial perineal muscles are very pale and poorly developed in the female so that their exact definition is a matter of difficulty.

The ischio-cavernosus covers the crus of the clitoris. It arises from the inner aspect of the ischial tuberosity as in the male, and ends in a membranous expansion over the crus clitoridis. It is supplied by the internal pudendal nerve.

The sphincter vaginae covers each half of the bulb and is the homologue of the ejaculator urinae muscle of the male. It arises posteriorly from the central point of the perineum, and sweeps forwards on each side of the vaginal orifice upon which it exerts a sphincteric action. It is innervated by the internal pudendal nerve.

The transversus perinei is usually difficult to define in the female. It arises as in the male from the inner aspect of the ischial tuberosity and is inserted into the central point of the perineum where it meets its fellow of the opposite side, the sphincter vaginae, the sphincter ani and the levator ani muscles. Its nerve is derived from the internal pudendal.

DISSECTION.—Remove the superficial perineal muscles and expose the structure of the clitoris which is the homologue of the penis. Its dorsal portion is composed of two corpora cavernosa as in the male, and to the anterior ends of these the glans clitoridis is attached. The posterior ends of the corpora cavernosa separate as in the male to form the crura which are attached to the pubic rami.

The bulb in the female is in right and left halves which are situated upon each side of the vaginal orifice under cover of the sphincter vaginae. Their anterior ends are connected with the glans clitoridis by means of a plexus of small veins termed the pars intermedia.

The gland of Bartholin will be found lying under cover of the bulb. Its mucous-like secretion is discharged by means of its duct, which opens on to the vestibule directly internal to the labium minus.

The triangular ligaments (both superficial and deep layers) are feebly developed in the female, but enclose the same muscle as in the male, namely the compressor urethrae. The same structures, with the exception of Cowper's glands, will be found lying in their relative positions between the two layers of the triangular ligament, as in the case of the male.

In the female there are the dorsal vein of the clitoris, the dorsal arteries of the clitoris and the dorsal nerves of the clitoris, bearing the same relations to one another as in the male. They are however very much smaller.

THE MALE PELVIS.

DISSECTION.—The best way to study the relations of the pelvic viscera is to make a mesial sagittal section of the pelvis under the supervision of the demonstrator. Previous to this, however, examine the disposition of the pelvic peritoneum.

THE PERITONEUM OF THE MALE PELVIS.

The Peritoneum leaves the posterior aspect of the rectum at its very commencement opposite the third piece of the sacrum. It gradually leaves the sides of the rectum, when traced downwards, thus forming the pararectal fossa. The peritoneum finally leaves the anterior surface of the rectum at the junction of its upper two thirds and lower third, and is then reflected on to the base of the bladder about its middle, thus forming the recto-vesical pouch of peritoneum in which rests the pelvic colon. The peritoneum covers the upper half of the base of the bladder, including the deferent ducts and the upper ends of the seminal vesicles, sweeps forwards over the upper surface of the bladder which it covers completely and is finally reflected from the apex of the bladder on to the anterior abdominal wall by the urachus to form the anterior false ligament of the bladder. Laterally the peritoneum is carried off from the upper surface of the bladder on to the side wall of the pelvis by the obliterated hypogastric artery as it proceeds forwards towards the anterior abdominal wall.

The recto-vesical fossa is the deep peritoneal pouch lying between the rectum and bladder in which rests the loop of pelvic colon. On each side wall a faint ridge may be seen descending. This is produced by the ureter and may therefore be termed the ureteral ridge. A little lower there may be seen a slight peritoneal ridge, the sacro-genital fold, which sweeps forwards from the posterior pelvic wall to end on the base of the bladder. The pararectal fossa is the slight recess on each side of the rectum, while the depression seen on each side of the bladder when it is full, is known as the paravesical fossa.

DISSECTION.—After the pelvis has been sectioned mesially, choose one half and strip the peritoneum and viscera from its side wall right down to the pelvic floor. Remove all the adipose tissue from the side wall and pelvic floor. At the same time define the internal iliac vessels, and after removing many veins, expose the branches of the artery and trace them inwards. The pelvic fascia may then be studied, together with the pelvic diaphragm which is composed of the levator ani and coccygeus muscles of both sides.

THE INTERNAL ILIAC ARTERY.

This artery arises opposite the lumbo-sacral disc as the smaller terminal branch of the common iliac. It descends almost vertically into the pelvis, and ends at the upper margin of the great sciatic foramen by dividing into anterior and posterior divisions. In front and to the inner side it is covered by pelvic peritoneum. The ureter also runs downwards directly in front of it, while the colon is an extra anterior relation on the left side. Behind is its own vein, together with the sacral plexus. Externally it is separated from the lateral wall of the pelvis by the external iliac vein.

The posterior division of the artery divides into the superior gluteal, lateral sacral and ilio-lumbar arteries. The superior gluteal is the largest of these and escapes from the pelvis through the great sciatic foramen above the pyriformis. Its further course has been previously studied.

The lateral sacral artery supplies the tissues in front of the sacrum, and sends branches to the spinal cord and its membranes through the anterior sacral foramina. It also anastomoses with the middle sacral.

The ilio-lumbar artery turns upwards towards the pelvic brim, and divides into iliac and lumbar branches of which the former passes under the iliacus to supply it and the ilium, while the lumbar branch runs upward to supply the psoas and anastomose with the lumbar arteries.

The anterior division of the internal iliac artery is directly continuous with the obliterated hypogastric artery which passes forwards by the side of the bladder and mounts upwards on the anterior abdominal wall to reach the umbilicus. It is pervious, however, for a very short distance and gives off the superior vesical artery which supplies the upper portions of the bladder and also furnishes the artery to the ductus deferens. The anterior division of the internal iliac artery gives off other two visceral branches—the inferior vesical and middle haemorrhoidal and three parietal branches—the obturator, internal pudendal and inferior gluteal.

The inferior vesical supplies the lower portions of the bladder and the prostate.

The middle haemorrhoidal supplies the rectum and anastomoses with the superior and inferior arteries as already studied.

The obturator artery runs forwards on the side wall of the pelvis to meet the obturator nerve with which it enters the obturator foramen. It is distributed mainly to the deep surface of the obturator externus muscle and forms an arterial circle round the obturator foramen. It also supplies a twig to the hip joint. Note once more the anastomosis on the back of the pubis between the obturator artery and the deep epigastric which may result in the formation of the abnormal obturator artery which arises from the deep epigastric.

The internal pudendal and inferior gluteal arteries arise by a common stem which runs downwards in front of the pyriformis muscle and then divides into these at its lower border. They escape from the pelvis through the great sciatic foramen. Their further course has been already studied.

The venous plexuses surrounding the prostate and the lower portion of the bladder are worthy of mention. They are drained by the vesical veins. The internal iliac vein receives tributaries corresponding to the branches of the artery, except the ilio-lumbar vein which enters the common iliac. The internal iliac vein runs upwards posterior to the artery and joins the external iliac vein to form the common iliac.

THE PELVIC FASCIA.

The pelvic muscles, as in the case of all muscular tissue, possess fibrous sheaths to which the term pelvic fascia has been applied. This is grouped under two headings namely, parietal and visceral pelvic fascia.

The parietal pelvic fascia is represented by the sheaths covering the pelvic surfaces of the pyriformis on the posterior wall, the compressor urethrae between the pubic rami, and the obturator internus on the lateral wall. The fascia covering the latter muscle is the most important, and is termed the obturator fascia. This is attached to the posterior part of the pelvic brim where it becomes continuous with the fascia iliaca. When traced forwards, however, its line of attachment descends rapidly along the upper border of the obturator internus to the level of the lower end of the posterior surface of the pubis. Opposite the point of exit of the obturator vessels and nerve it sweeps over the upper border of the muscle to obtain attachment to the obturator membrane. The line of attachment of the obturator fascia inferiorly is along the rami of the pubis and ischium and to the tuberosity of the ischium and the sacro-tuberous ligament.

The visceral pelvic fascia is the sheath investing the upper or pelvic surfaces of the levator ani and coccygeus muscles. It will not be understood until these muscles have been described.

The levator ani possesses a continuous line of origin from the posterior aspect of the pubis, from the obturator fascia and from the inner aspect of the ischial spine, at which point it is in direct continuity with the coccygeus which lies more posteriorly. The muscle fibres are directed inwards and backwards, those most posterior obtaining insertion into the margin of the coccyx; while between this and the anal canal they meet their fellows of the opposite side in a mesial intersection termed the ano-coccygeal body. The most anterior fibres are directed backwards by the side of the prostrate which they support very closely, and they then meet their fellows in the central point of the perineum. The levator ani is supplied by the fourth and fifth sacral nerves. Its action is to support the pelvic viscera along with the coccygeus, the muscles of opposite sides thus constituting the pelvic diaphragm.

The coccygeus muscle is directly continucus with the levator ani and takes origin with it from the deep aspect of the ischial spine. Its fibres run backwards and inwards to obtain insertion into the margin of the coccyx. Its nerve supply and action are the same as those of the levator ani. Note that the sacro-spinous ligament covers its superficial aspect.

The visceral pelvic fascia will now be recognised as forming the sheath for the upper or pelvic surfaces of the levator ani and coccygeus muscles. Its upper border (termed the white line) thus follows the line of attachment of these muscles to the posterior surface of the pubis, the obturator fascia and the inner surface of the ischial spine. When traced towards the viscera it will be found to blend with the sheaths of the prostate and bladder (the vesical portion), and the rectum (the rectal portion). The intermediate portion that passes between the bladder and rectum might thus be termed recto-vesical. Posteriorly the visceral layer of the pelvic fascia does not extend beyond the coccygeus, thus leaving a gap through which the sacral plexus quits the pelvis. Anteriorly the fascia sweeps round the free edge of the levator ani muscle that passes backwards from the pubis, thus forming the pubo-prostatic ligament of that side.

THE MALE RECTUM.

The rectum begins in the mid line in front of the third piece of the sacrum as the continuation of the pelvic colon. Its course is slightly wavy and follows the concavity of the sacrum and coccyx. It ends one inch in front of the tip of the coccyx by bending downwards and backwards into the anal canal. The rectum is about 5 inches long. Anteriorly it is covered in its upper two thirds by the peritoneum of the recto-vesical pouch in which lies a loop of pelvic colon. The lower third is in relation to the base of the bladder from which it is separated by the deferent ducts and seminal vesicles, and also to the posterior surface of the prostate, which lies just in front of the bend of the rectum. Posteriorly the rectum is bound to the sacrum, coccyx and ano-coccygeal body by dense connective tissue. On each side of the upper part of the rectum is the pararectal peritoneal fossa. Lower down, however, the rectum lies in a gutter formed by the fibres of the levator ani and coccygeus muscles as they converge on the coccyx. The course of the rectum is slightly wavy, with two concavities to the left and one to the right. Corresponding to these bends there are three folds of mucous membrane, known as the rectal valves, in the interior, of which two are usually to the left and one to the right.

The anal canal is one and a half inches long and is directed downwards and backwards from the termination of the rectum. Posteriorly is the anococcygeal body, and on each side is the levator ani muscle covered by its fascia. Anteriorly the anal canal is separated from the urethra by an angular gap in which is the central point of the perineum formed by the union of the levator ani, transversus perinei, ejaculator urinae and external sphincter muscles. The anal orifice is surrounded by the external sphincter, while there is a thickening of the circular coat of the canal for its last inch, constituting the internal sphincter.

The mucous membrane of the anal canal is arranged in longitudinal columns, the lower ends of which are connected just inside the anal orifice by the socalled anal valves. The latter indicate the line of junction of the hind gut with the proctodaeum in the embryo, and therefore the line of union (white line) of the stratified squamous epithelium of the skin with the columnar epithelium of the intestine.

THE MALE BLADDER.

The bladder possesses an apex, a base, a superior surface, two inferolateral surfaces, and a neck.

The apex rests against the anterior abdominal wall at the upper border of the symphysis pubis (when the bladder is empty) and affords attachment to the urachus which passes from it to the umbilicus. When the bladder is distended it rises into the abdomen, and in so doing separates off the peritoneum from the anterior abdominal wall.

The base of the bladder is directed towards the rectum, from which its upper half is separated by the recto-vesical pouch, containing the loop of pelvic colon. Its lower half is separated from the rectum by the deferent ducts, the seminal vesicles and some connective tissue. Each ureter is attached to the base of the bladder just external to the upper end of the seminal vesicle.

The superior surface of the bladder is completely covered by peritoneum and upon it rest coils of small intestine. Arching backwards on each side of its posterior part in order to reach the base will be found the deferent duct.

Each infero-lateral surface of the bladder is in relation to the obturator internus and levator ani muscles, being separated from these by the pelvic fascia and loose connective tissue. Running forward on each lateral aspect of the bladder is the obliterated hypogastric artery, which is crossed here by the ductus deferens. Note that the bladder rests against the upper part of the symphysis pubis, but is separated from the lower part by a mass of adipose tissue termed the retro-pubic pad of fat.

The neck of the bladder is surrounded by the base of the prostate and is attached anteriorly to the pubic bones by the pubo-prostatic ligaments between which lies the dorsal vein of the penis. The neck of the bladder is continuous with the urethra.

The mucous membrane of the bladder is markedly rugose except over the trigone where it is quite smooth owing to the fact that it is firmly bound down to the muscular coat over that area. The trigone is the triangular area mapped out by the two ureteral openings and the urethral orifice. A small projection of the mucous membrane immediately behind the urethral orifice is termed the uvula vesicae.

The muscular coat consists of outer, intermediate and internal layers. The fibres of the outer and inner coats run for the most part longitudinally, while those of the intermediate layer are disposed in a circular manner and are thickened at the neck of the bladder to form its sphincter.

The true ligaments of the bladder are five in number—the urachus, the lateral ligaments composed of the visceral pelvic fascia, and the puboprostatic ligaments.

The false ligaments are composed of peritoneum and are also five in number—

(1) The superior false ligament is the peritoneum that is carried off from the apex of the bladder on to the anterior abdominal wall by the urachus;

(2) and (3) The lateral false ligaments are the layers of peritoneum carried off from the superior surface on to the side wall of the pelvis on each side by the obliterated hypogastric artery;

(4) and (5) The posterior false ligaments are the sacro-genital folds, already described

THE PROSTATE.

The prostate consists of a mass of non-striped muscle in which mucous glands are imbedded. It surrounds the neck of the bladder and the first or prostatic portion of the urethra; and consists of a base, an apex, and anterior, posterior and lateral surfaces.

The base is directed upwards and surrounds the neck of the bladder.

The apex is directed downwards and rests upon the deep surface of the compressor urethae muscle. From it the urethra emerges.

The anterior surface of the prostate is attached to the posterior aspect of the pubes by the pubo-prostatic ligaments between which lies the dorsal vein of the penis.

The posterior surface is in close relation to the termination of the rectum, a thin layer of connective tissue alone intervening. The upper end may exhibit a notch indicating the bilateral origin of the prostate.

The lateral surfaces are intimately invested by the levator ani muscles, the pelvic fascial covering of which provides the outer capsule of the prostate.

The dimensions of the prostate are one and a half inches from side to side, one inch from before backwards and one and a quarter inches from the base to the apex.

The prostate possesses two capsules. The inner is the capsule of the gland proper and is intimately attached to its substance. The outer sheath is derived from the pelvic fascia. Between the two capsules lies the prostatic plexus of veins which is joined anteriorly by the dorsal vein of the penis.

The common ejaculatory ducts will be found to traverse the prostate from behind, and in so doing imperfectly map off a portion of the prostatic substance between them and the neck of the bladder, which is known as the "middle lobe" of the prostate. In senile enlargement of the prostate this portion hypertrophies, and presses upon the neck of the bladder thus interfering with micturition.

THE MALE URETHRA.

The male urethra is about 8 inches long and consists of the prostatic, membranous and penile portions.

The prostatic portion is directed almost vertically downwards from the neck of the bladder. It is enclosed throughout its course by the prostate, and is thus one and a quarter inches long. It is nearer the anterior than the posterior surface of the prostate Note that it is the widest portion of the urethra. In

cross section it is crescentic in outline owing to the presence of a longitudinal ridge termed the verumontanum which projects forwards from its posterior wall. If the centre of this ridge be examined with a small probe, a tiny recess will be discovered. This is the homologue of the female uterus and is therefore termed the uterus masculinus. On each lateral lip of this opening is the orifice of the common ejaculatory duct. It should be noted that the ducts of the prostatic mucous glands open into the recess on each side of the verumontanum.

The membranous portion of the urethra is three quarters of an inch long and is thus the shortest portion. It is also the narrowest portion. It describes a gentle curve, concave forwards, which at all points is about one inch from the lower end of the symphysis pubis. This portion is imbedded in the compressor urethrae muscle throughout its course, and thus lies between the two layers of the triangular ligament.

The penile portion traverses the bulb, corpus spongiosum and glans penis, in the erectile tissues of which it is imbedded throughout its whole course. Its external opening on the glans is a vertical slit termed the meatus urinarius. Immediately inside this the canal widens slightly into a spindle shaped cavity termed the navicular fossa, from the roof of which a slight recess known as the lacuna magna extends backwards and may thus catch the point of a catheter. The wall of the penile urethra possesses a few mucous glands, while Cowper's glands open into its very commencement.

The ductus deferens after leaving the other constituents of the spermatic cord at the abdominal inguinal ring sweeps downwards into the pelvis across the external iliac vessels directly under the peritoneum. It then passes over the obliterated hypogastric artery as it approaches the side of the bladder. After arching over the upper surface of the bladder it turns downwards on the base, directly internal to the seminal vesicle, and ends by joining the duct of the latter to form the common ejaculatory duct which tunnels the prostate to open into the prostatic urethra, as previously shown.

The seminal vesicle is a sacculated structure about two inches long which is bound down to the base of the bladder by areolar tissue. Its upper part is covered by peritoneum, and the ureter joins the bladder just external to its upper end. Its lower portion is separated from the rectum by connective tissue.

The ureter in the pelvic portion of its course is directed downwards immediately in front of the internal iliac artery. It then curves gently downwards and forwards on the side wall of the recto-vesical pouch on which it forms the ureteral ridge. It opens on to the upper part of the base of the bladder just external to the upper end of the seminal vesicle. It is thus covered merely by peritoneum during its pelvic course. It tunnels the bladder wall for about three quarters of an inch before finally opening on to its interior, thus producting a sort of valve effect.

THE SACRAL PLEXUS.

This plexus is formed by the lumbo-sacral cord and the anterior divisions of the first four sacral nerves. The lumbo-sacral cord, as previously shown, is

formed by the union of a branch from the fourth lumbar nerve with the fifth. It passes downwards in front of the lateral mass of the sacrum to enter the pelvis. The greater part of the sacral plexus seems to pass into the sciatic nerve which is formed by the lumbo-sacral cord and the first three sacral nerves. The internal pudendal nerve is another well marked branch, and is formed by roots from the second, third and fourth sacral nerves. The superior and inferior gluteal nerves take origin from the lumbo-sacral cord and the upper one or two sacral nerves The posterior cutaneous nerve of the thigh arises from the first three sacral nerves. The perforating cutaneous twig from the second and third sacral and the perineal branch of the fourth sacral have been previously studied in the ischio-rectal fossa. The nerves to the obturator internus and the quadratus femoris have very ill defined origins, and appear to spring from the roots of the sciatic nerve. The visceral branches from the third and fourth sacral nerves should be specially looked for. They join the pelvic plexuses and contain the twigs of supply to the sphincters of the rectum and bladder and also the nervi erigentes to the penis

The fifth sacral nerve and the coccygeal nerve are rudimentary in man, following the suppression of the caudal appendage. It may be noted once more that the fourth and fifth sacral nerves supply the pelvic diaphragm.

THE SYMPATHETIC CORDS IN THE ABDOMEN AND PELVIS.

The sympathetic cords in the abdomen and pelvis will be found lying in front of the bodies of the vertebrae. They enter the abdomen behind the internal arcuate ligaments and run downwards along the anterior borders of the psoas muscles. They enter the pelvis behind the common iliac vessels and run downwards internal to the anterior sacral foramina. Their lower ends terminate in the ganglion impar on the front of the coccyx. As a rule five ganglia can be counted on each cord in the lumbar region and five in the sacral region. These communicate as usual with the corresponding spinal nerves and in addition send offshoots to the solar and pelvic plexuses.

The right and left pelvic plexuses are derived from the aortic plexus, as already shown. They follow the course of the corresponding internal iliac arteries and therefore furnish vesical, prostatic and haemorrhoidal offshoots to the bladder, prostate and rectum. They are joined by visceral twigs from the third and fourth sacral nerves, as already indicated.

The lymph glands of the pelvis are massed mainly along the course of the internal iliac artery. They drain the lymph from the pelvic viscera and empty into the afferent vessels of the lumbar glands. The lymph from the external genitalia, as already shown, passes to the superficial inguinal glands.

THE FEMALE PELVIS.

DISSECTION.—The pelvic peritoneum will be first studied, and the pelvis is then to be sectioned mesially as in the case of the male.

The pelvic peritoneum in the female leaves the posterior aspect of the rectum at its very commencement, as in the male. It then gradually leaves the sides of the bowel, thus forming the pararectal fossae. It leaves the front of the rectum at the junction of its upper two thirds and lower third, as in the male; and is reflected from there on to the upper three quarters of an inch of the posterior vaginal wall. It mounts upwards on the posterior wall of the uterus, sweeps forwards over the fundus, and descends on the anterior wall to the junction of the body with the cervix at which point it is reflected on to the base of the bladder. It covers the upper half of the latter, as well as the whole of the upper surface of the bladder, as in the male; and is carried off from the apex by the urachus on to the anterior abdominal wall as the superior false ligament of the bladder. On each side the peritoneum is carried off from the bladder on to the side wall of the pelvis by the obliterated hypogastric artery, as in the male.

The utero-rectal and utero-vesical pouches of peritoneum are well marked features of the female pelvis. The former is the deeper of the two and exhibits on each side wall the utero-sacral fold, produced by the utero-sacral ligament, which passes from the sacrum to the uterus at the junction of the body with the cervix. The utero-rectal pouch is sometimes known as the pouch of Douglas, and is occupied normally by the loop of pelvic colon. The utero-vesical pouch is limited on each side by a slight fold, and is occupied normally by coils of small intestine. Note that there is no ureteral ridge on the side wall of the female pelvis owing to the presence of the uterine broad ligament.

The levator ani and coccygeus have the same dispositions as in the male with the additional point that the levator ani fibres are inserted into the walls of the vagina, with which the visceral pelvic fascia also blends. The anatomy of the remainder of the pelvic fascia is the same as in the male. The pubo-prostatic ligaments must of course be termed "pubovesical" owing to the absence of the prostate in the female. They blend with the neck of the female bladder and the beginning of the urethra.

THE FEMALE RECTUM.

The whole anatomy of the female rectum corresponds to that of the male except its anterior relations. The upper two thirds of its anterior wall are separated from the uterus and vagina by the utero-rectal pouch containing the loop of pelvic colon. The lower third, including the bend of the rectum, is in intimate contact with the posterior vaginal wall.

The whole anatomy of the female anal canal corresponds to that in the male excepting its anterior relations. Its anterior wall is separated from the lower part of the posterior vaginal wall by a wedge shaped mass of fibro-muscular tissue, known as the "obstetrical perineum." This tissue includes the central point of the perineum, formed by the union of the levator ani, transversus perinei, sphincter vaginae and sphincter ani externus muscles.

The whole anatomy of the female bladder corresponds to that of the male excepting the relations of the base and the neck. The upper half of the base

of the female bladder is separated from the body of the uterus by the utero-vesical pouch containing coils of small intestines. The lower half is in direct contact with the cervix uteri and the upper half of the anterior vaginal wall, a thin layer of connective tissue alone intervening. The neck of the bladder is enclosed between the edges of the two levator ani muscles, and has attached to it anteriorly the pubo-vesical ligaments.

The five true ligaments of the female bladder correspond to those of the male, and all the false ligaments also correspond except the two posterior which in this case pass from the base of the bladder to the uterus on each side of the utero-vesical pouch.

The female urethra is one and a half inches long and is directed downwards and forwards from the neck of the bladder. It is in intimate contact posteriorly with the lower half of the anterior vaginal wall. It is partially surrounded by the compressor urethrae muscle and also higher up by a plexus of veins which is joined by the dorsal vein of the clitoris. Its external opening has been previously studied. A few mucous glands which open into its upper part are the homologues of the prostatic tubules of the male.

THE UTERUS.

The uterus is pear shaped, the broad upper end being termed the fundus, while the narrow end exhibits the os externum which opens into the upper end of the vagina. The fundus should normally touch the plane of the pelvic brim. The upper two thirds of the uterus are called the body while the lower third is termed the cervix. The body is slightly tilted forwards so that it forms a slight angle with the cervix. This is termed anteflexion. Moreover, the whole uterus forms a slight angle with the vagina—this being termed anteversion. The uterus is 3 inches long, 2 inches wide between its lateral angles and one inch thick.

The posterior surface of the uterus is entirely covered by peritoneum and is separated from the rectum by the utero-rectal pouch containing pelvic colon. Note that it is more convex than the anterior surface.

The anterior surface is only covered in its upper two thirds by peritoneum and is therefore separated from the base of the bladder by the utero-vesical pouch containing coils of small intestine. The lower third or cervix is in intimate contact with the base of the bladder and is firmly bound to it by connective tissue.

Each lateral angle of the uterus will be observed to afford attachment to the uterine or Fallopian tube; while each lateral margin has attached to it the two layers of the broad ligament.

The cavity of the body of the uterus when examined later will be found to be smooth and triangular in outline, the upper angles representing the openings of the uterine tubes, while the lower angle is continuous with the canal of the cervix and is known as the os internum.

The cavity of the cervix is rather spindle shaped and its mucous membrane exhibits a peculiar pattern like the branches of trees. The external os will be studied with the vagina. Note that the uterus and uterine tubes are lined by ciliated epithelium.

THE BROAD LIGAMENT.

The broad ligament extends outwards and slightly backwards from each lateral margin of the uterus. It reaches the side wall of the pelvis opposite the sacro-iliac joint, and there its layers open apart in anterior and posterior directions. Its upper margin encloses the uterine tube, but after this opens into the peritoneal cavity, the edge of the broad ligament itself is continued onwards to the pelvic brim as the infundibulo-pelvic fold which contains the ovarian vessels, nerves and lymphatics.

The uterine tube is 3 to 4 inches long and is enclosed in the upper margin of the broad ligament. The portion next to the uterus is very thin and is sometimes termed the isthmus. Towards its outer end it arches above the ovary and dilates slightly to form the ampulla. Its outer extremity exhibits a slightly funnel shaped aperture termed the infundibulum, which opens into the peritoneal cavity to receive the ova discharged from the surface of the ovary. The infundibulum is surrounded by a fringe of delicate processes covered with cilia. These are the fimbriae, and one of them, known as the ovarian fimbria, is always attached to the outer pole of the ovary.

The ovary will be found dangling from the posterior surface of the broad ligament. It is ovoid in shape, is over one inch long, half an inch wide and a quarter or an inch or more in thickness. It lies obliquely, its outer pole being a little higher than its inner. The outer pole is directed towards the infundibulum of the uterine tube and is attached to it by the ovarian fimbria. Close to it may be found the stalked hydatid which is the remains of the pronephros. The inner or uterine pole of the ovary is directed towards the uterus, to the lateral angle of which, close to the junction of the uterine tube, it is attached by means of the ovarian ligament. The anterior border of the ovary represents its line of attachment to the broad ligament. It is therefore straight and may be termed the hilum, since the blood vessels and nerves enter here. The posterior border is rounded, convex and free, and therefore hangs downwards, so that one surface of the ovary looks upwards and backwards, and the other downwards and forwards.

Between the ovary and the uterine tube a collection of atrophied tubules may be seen between the layers of the broad ligament. These represent the parovarium which is the remains of the mesonephros, and is thus the homologue of the epididymis of the male.

The round ligament of the uterus will be observed to be attached to the lateral angle of the uterus beside the junction of the uterine tube. It is directed outwards and forwards and in so doing carries off a fold from the anterior layer of the broad ligament. It then sweeps upwards above the obliterated hypo-

gastric artery and crosses in front of the external iliac vessels in order to enter the abdominal inguinal ring. It traverses the inguinal canal and ends in the connective tissue of the labium majus. It is thus the remains of the gubernaculum of the foetus and may pull a slight pocket of peritoneum into the inguinal canal.

The ovarian vessels after crossing the external iliac artery just in front of the ureter pass between the layers of the infundibulo-pelvic fold. They are then continued between the layers of the broad ligament just below the uterine tube, and end by anastomosing with the uterine vessels at the lateral angle of the uterus. In addition to the ovary the artery supplies the uterine tube and the fundus of the uterus. Therefore the lymph vessels from these proceed upwards to the lumbar glands by the side of the aorta. It may be mentioned that the lymph from the remainder of the uterus and vagina passes to the internal iliac glands.

On exposing the distribution of the internal iliac artery in the female it will be noted that its branches correspond to those in the male, with the addition of the uterine artery which passes inwards above the ureter to reach the lateral margin of the uterus along which it runs. It lies between the layers of the broad ligament and dispenses twigs to both surfaces of the uterus. It also supplies a vaginal artery to the vagina, which may, however, arise independently from the internal iliac.

The visceral branches of the internal iliac artery, together with their accompanying veins, are imbedded in a mass of connective tissue (the parametrium) which thus acts as a supporting ligament that binds the uterus to each lateral wall of the pelvis.

THE VAGINA.

The vagina is about 3 inches long, its posterior wall being the longer. It is directed downwards and forwards. The os externum of the uterus projects with smooth rounded lips into its upper end, thus producing anterior, posterior and lateral recesses termed the fornices. Of these the posterior fornix is the deepest

The posterior wall of the vagina is in relation at its upper end to the peritoneum of the utero-rectal pouch for about three quarters of an inch. Below this it is in intimate relation to the termination of the rectum, while its lower part is separated from the anal canal by the "obstetrical perineum" as previously shown

The anterior vaginal wall is in intimate relation in its upper half with the base of the bladder, and in its lower half with the urethra.

Each lateral wall is closely supported by the levator ani muscle and the visceral pelvic fascia. On each side opposite the lateral fornix the lateral vaginal wall is in close relation to the ureter which at this point is crossed superiorly by the uterine artery. This is an important clinical point in forceps delivery.

The orifice of the vagina is guarded by the hymen in the virgin and is enclosed on each side by the sphincter vaginae under cover of which are the bulb and the gland of Bartholin.

The mucous membrane of the vagina is very rugose and is lined by stratified squamous epithelium.

The female ureter sweeps downwards in front of the internal iliac artery as in the male. It then curves forwards by the side of the upper end of the lateral vaginal wall at the level of the lateral fornix and os externum. At this point it is crossed superiorly by the uterine artery. Just in front of this it enters the upper lateral aspect of the base of the bladder, as in the male.

THE HEAD AND NECK.

DISSECTION.—Reflect the skin from the anterior quadrant of the scalp. This should be done under the supervision of the demonstrator, as the skin is thin and firmly bound down to the aponeurosis by fibrous strands.

THE SCALP.

The scalp is composed of five layers—

*S*kin

*C*utaneous fat.

*A*poneurosis

*L*oose areolar tissue

*P*eriosteum of the cranial bones

The following cutaneous nerves will be found in the cutaneous fat of this area. Sweeping upwards on to the forehead through the supraorbital notch or foramen is the supraorbital nerve. This is readily located at the junction of the inner third and the outer two thirds of the supraorbital margin. The supratrochlear nerve curves upwards round the inner end of the same margin, and is smaller than the preceding. The small temporal branch of the temporo-malar nerve may be found emerging behind the posterior edge of the malar bone, while the well marked auriculo-temporal nerve is directed upwards immediately in front of the external ear or auricle. It supplies sensory branches to the latter and to the temporal region of the scalp. It should be noted that all four nerves are branches of the fifth cranial nerve, which is the great sensory nerve of the face. The temporal branches of the seventh cranial (facial) nerve will be found passing upwards over the zygoma. These temporal twigs innervate the muscles of the frontal region and the extrinsic muscles of the ear.

The arteries of the anterior quadrant of the scalp are the frontal, supraorbital and superficial temporal which accompany the supratrochlear, supraorbital and auriculo-temporal nerves closely. The two first named arteries are branches of the ophthalmic, while the superficial temporal is one of the terminal branches of the external carotid artery. The superficial temporal artery will be observed crossing the root of the zygoma immediately in front of the ear. It supplies the

latter and soon divides into anterior and posterior branches, of which the former passes forwards to anastomose with the supraorbital and frontal, while the posterior branch curves backwards into the posterior quadrant of the scalp to anastomose with the posterior auricular and occipital arteries. In addition to its terminal branches to the scalp, the superficial temporal artery gives off the middle temporal artery to the temporal muscle and a muscular branch to the orbicularis oculi. It also furnishes twigs to the parotid gland and the external ear and the transverse facial artery which will be studied in the face.

DISSECTION.—The best way to remove the cutaneous fat is to scrape it off the aponeurosis and the frontalis muscle with a knife gently. This is the only satisfactory way of cleaning all the facial muscles, as they are exceedingly thin, and their fibres are very pale in colour.

The frontalis muscle is attached below to the orbicularis oculi, with the fibres of which it forms an elaborate series of intersections. At the root of the nose it is continuous with the pyramidalis nasi muscle and with its fellow of the opposite side. The fibres form a thin stratum which sweeps upwards over the forehead to obtain insertion into the epicranial aponeurosis. It is innervated by the temporal branches of the facial nerve. It acts as a muscle of facial expression.

The epicranial aponeurosis is really the expanded intermediate tendon connecting the frontalis with the occipitalis muscle which lies in the occipital region of the scalp. Laterally it is attached to the mastoid process, to the external ear and to the zygomatic arch. In addition it affords origin laterally to a few stray muscle fibres which pass downwards and backwards to the ear, and represent the atrophied remains of the attollens and attrahens, two of its extrinsic muscles. These are supplied by the temporal branches of the facial nerve.

Scalping takes place through the fourth layer of the scalp, namely the loose areolar tissue. If the first three layers be severed, the flap thus produced can be peeled off like an orange. Suppuration in this layer of the scalp is very serious as the pus is apt to burrow under the aponeurosis for considerable distances, and may involve the fifth layer or periosteum, thus producing necrosis of the cranial bone.

THE FACE.

DISSECTION.—The skin has to be removed from the face after stitching up the eyelids and the mouth. Confine the attention first of all to the parotid gland which is situated immediately below the zygoma. Define its duct and the branches of the facial nerve that pierce it. The gland has then to be removed piece by piece in order to expose the facial nerve, the external carotid artery and the temporo-maxillary vein.

THE PAROTID GLAND.

This is the largest of the salivary glands, and is situated for the most part in the recess between the ramus of the lower jaw and the mastoid process; but it is tucked away into every available recess in the vicinity, thus imparting a very irregular outline to the gland. Superficially it is covered by a very resistant sheath of fascia, which is continuous below with the cervical fascia, and is attached above to the zygomatic arch, the latter thus demarcating the upper limit of the gland. Posteriorly it is in relation to the tympanic plate, the external auditory meatus, the mastoid process and the sterno-mastoid muscle. Below it rests upon the posterior belly of the digastric muscle and the stylo-mandibular ligament, while anteriorly it is in contact with the posterior edge of the ramus of the mandible. It encroaches upon this to a considerable degree, and thus comes to overlap the masseter muscle superficially and the internal pterygoid muscle deeply. The deep relations of the parotid gland are important for it rests upon the internal carotid artery and the internal jugular vein, between which lie the ninth, tenth, eleventh and twelfth cranial nerves. The deep surface is also in close relation in front of these structures with the styloid process and its three muscles.

The parotid gland is traversed by four arteries,—the external carotid, the superficial temporal, the internal maxillary and the transverse facial; also by the temporo-maxillary vein, and the facial nerve, which here receives communicating twigs from the great auricular and auriculo-temporal nerves. Of the three most important structures the facial nerve is the most superficial, the external carotid is deepest and the vein is intermediate. The six terminal branches of the facial nerve emerge from the anterior border of the gland, as also does the parotid duct which runs forwards on the masseter, a finger's breadth below the zygoma, and sweeps round the anterior border of that muscle in order to pierce the buccinator and the mucous membrane of the cheek opposite the second molar tooth of the upper jaw. The line of the duct is indicated on the surface by the middle third of a line drawn from the lower border of the external auditory meatus to a point midway between the ala of the nose and the red margin of the upper lip. A tiny semi-detached lobule of gland substance may often be found lying between the parotid duct and the zygoma, in which situation the transverse facial artery will also be found.

THE FACIAL NERVE.

This nerve will be found to emerge from the base of the skull through the stylo-mastoid foramen. The main trunk sweeps forwards in the parotid gland superficial to the temporo-maxillary vein and the external carotid artery, and soon breaks up into a plexiform network from which six main branches proceed. Named from above downwards these are—(1) temporal, (2) malar, (3) infraorbital, (4) buccal, (5) mandibular, (6) cervical. The temporal branches have

been already found in the scalp, supplying the frontalis and the attollens and attrahens muscles of the ear. They also supply the corrugator supercilii and the upper half of the orbicularis oculi. The malar branch supplies the lower half of the latter muscle, and also some of the muscles going to the upper lip. The main nerve supply to these, however, is from the infraorbital branch. The buccal nerve supplies the buccinator. The mandibular branch supplies the muscles passing to the lower lip, except the platysma which is supplied by the cervical branch. The trunk of the facial nerve immediately after emerging from the skull supplies the stylo-hyoid, the posterior belly of the digastric muscle, and the posterior auricular nerve which runs upwards behind the ear, and innervates its retrahens muscle and the occipitalis.

DISSECTION.—In tracing the branches of the facial nerve on to the face the adipose tissue of the cheek has been removed. The facial muscles will then be scraped gently to clean them, and their arrangement defined.

THE FACIAL MUSCLES.

The facial muscles of expression are arranged in three groups—round the eye, round the nose and round the mouth.

The orbicularis oculi is a well marked muscle which surrounds the orbital aperture. A few muscle bundles which pierce it over the region of the eyebrow have been termed the corrugator supercilii. The outer circle of the orbicularis oculi consists of a series of loops which are attached internally to the frontal process of the superior maxilla, and are arranged concentrically. In the eyelids themselves, however, it may be noted that the muscle fibres are attached to the internal and external tarsal ligaments at the inner and outer angles of the lids respectively.

The muscles of the nose are very ill defined in man, and will be mentioned briefly. The pyramidalis nasi is really a continuation of the frontalis muscle at the root of the nose. The compressor naris which arises from the nasal notches of the superior maxillae, and sweeps over the bridge of the nose is perhaps the best defined. At the nostril a dilator muscle and a depressor and a levator of the ala of the nose have been described. These muscles like the others of the face are supplied by the facial nerve.

The orbicularis oris which surrounds the mouth is strongly developed. It is a composite structure, being formed by the intersection of numerous muscles which pass to it from all directions. For example, directed downwards to the upper lip is the levator labii superioris and directed upwards to the lower lip is the depressor labii inferioris. Similarly, directed downward to the angle of the mouth is the levator anguli oris, and directed upward to the angle is the depressor anguli oris. Three muscles converge on the orbicularis oris from behind. From above downwards these are the zygomaticus, the risorius and the platysma. These muscles are therefore all described as being inserted into the orbicularis oris. Note that the deeper strata of the orbicularis oris are formed by the buccinator muscles.

The levator labii superioris arises from the upper margin of the infraorbital foramen and from the frontal process of the superior maxilla. This muscle overlaps the origin of the levator anguli oris which thus arises from the lower margin of the infraorbital foramen. In contrast to this arrangement, note that the origin of the depressor labii inferioris from the external oblique line of the mandible is overlapped by that of the depressor anguli oris from the same line.

The zygomaticus arises from the outer surface of the malar bone and forms a well marked band of muscle. The platysma muscle constitutes one of the layers of the neck, and sweeps upwards over the base of the mandible in order to converge upon the angle of the mouth. The risorius is really composed of a few scanty detached fibres of the platysma which assume a horizontal position.

The buccinator muscle takes origin from the alveolar margins of both jaws opposite the three molar teeth and from the pterygo-mandibular ligament which separates it from the superior constrictor of the pharynx. The fibres from both muscles pass towards the angles of the mouth to form the deep strata of the orbicularis. The intermediate fibres form an elaborate decussation, while the upper and lower fibres pass uninterruptedly into the corresponding lip.

The levator menti is the name given to a bundle of muscle fibres which arises from the incisor fossa of the mandible and obtains insertion into the skin of the chin, which it corrugates by its contractions.

THE FACIAL ARTERY IN THE FACE.

The facial artery has been exposed during the process of defining the facial muscles. It reaches the face by passing upwards over the base of the mandible immediately in front of the masseter muscle. It wends a very tortuous course towards the inner angle of the eye where it ends as the angular artery which anastomoses with the ophthalmic. From below upwards it rests upon the lower jaw, the buccinator and the levator anguli oris muscles, while its terminal portion is imbedded in the levator labii superioris. Superficially it is overlapped by the platysma, risorius and zygomaticus muscles from below upwards.

In the facial part of its course the facial artery gives off—(1) inferior labial, (2) superior labial, (3) lateral nasal, (4) muscular and cutaneous branches. The labial arteries run inwards along the margins of the lips, and anastomose with their fellows of the other side. From this union, in the case of the upper lip, a small septal artery is sent upwards to the septum between the nostrils. The lateral nasal is the chief artery of supply to the nose. The muscular and cutaneous branches of the artery arise indiscriminately and one of these anastomoses with the transverse facial artery.

Note that the facial vein does not accompany the artery closely. It begins at the inner angle of the eye by the union of the prominent frontal vein with a small communicating vein from the ophthalmic. It runs downwards and backwards posterior to the artery, and comes to lie directly behind it at the base of the mandible.

DISSECTION.—Most of the facial muscles will have to be removed in order to expose the sensory branches of the fifth cranial nerve.

THE FIFTH NERVE IN THE FACE.

The fifth or trigeminal cranial nerve is the sensory nerve of the face, and it will be found that each of its three divisions furnishes three branches to the face. The first or ophthalmic division supplies the supratrochlear, supraorbital and nasal branches; the second or superior maxillary division furnishes the infraorbital, and the temporal and malar branches of the temporo-malar nerve; while from the third or inferior maxillary division are derived the long buccal, mental and auriculo-temporal nerves.

The supratrochlear and supraorbital nerves have been already studied in the frontal region of the scalp. The terminal portion of the nasal nerve appears on the nose between the lower border of the nasal bone and the lateral cartilage. It supplies the skin of the nose.

The temporal branch of the temporo-malar nerve has been previously studied in the temporal region of the scalp. Its malar branch emerges on to the face through the malar foramen, and supplies the skin of the cheek. The infraorbital nerve appears through the infraorbital foramen. It is well marked, and sends branches to the lower eyelid, to the side of the nose and to the upper lip.

The long buccal nerve appears on the face from under cover of the masseter muscle. It is the chief sensory nerve to the cheek, supplying both its skin and its mucous membrane. The mental nerve emerges from the mental foramen of the lower jaw, and supplies the skin of the chin. The auriculo-temporal nerve has been already studied in the temporal region.

THE POSTERIOR QUADRANT OF THE SCALP.

DISSECTION.—The skin must now be removed from the posterior quadrant of the scalp and from the posterior aspect of the neck in collaboration with the dissector of the upper limb.

The following cutaneous nerves will be exposed in the posterior quadrant of the scalp. Piercing the occipital origin of the trapezius in company with the occipital artery, within one inch of the external occipital protuberance, will be found the great occipital nerve which comes from the posterior division of the second cervical nerve and supplies a considerable area of skin. The small occipital nerve should be looked for as it runs upwards along the posterior border of the sterno-mastoid muscle, while the great auricular nerve will be found ascending vertically over the same muscle in order to supply the skin of the ear and the mastoid region of the scalp. The communicating twig from this nerve to the facial in the parotid gland has been already referred to.

The motor nerve of this region is the posterior auricular branch of the facial, which runs upwards behind the ear under cover of the retrahens muscle. It innervates the latter and the occipitalis muscle.

The arteries of the posterior quadrant of the scalp are the occipital and the posterior auricular, which are both branches of the external carotid artery. The occipital artery has been already noted as it pierces the occipital origin of the

trapezius in company with the great occipital nerve. It exhibits a very tortuous course over the occipital region of the scalp in company with its vein and after supplying the neighbouring tissues anastomoses with the superficial temporal and posterior auricular arteries.

The posterior auricular artery is much smaller than the preceding, and courses upwards behind the ear in association with the posterior auricular nerve. It furnishes a few twigs to the ear and the scalp, and anastomoses with the superficial temporal and occipital arteries.

The occipitalis muscle and the aponeurosis should now be gently scraped with the edge of the knife in order to clean them. The occipitalis will be observed to arise from the outer half or more of the superior curved occipital line, the aponeurosis itself obtaining attachment to the occipital bone to the inner side of this. After a brief course the scanty fibres of the occipitalis are inserted into the epicranial aponeurosis. It is innervated by the posterior auricular nerve and its action is to move the scalp in conjunction with the frontalis.

The retrahens extrinsic muscle of the ear is composed of two small slips which arise from the mastoid process and are inserted into the cranial surface of the external ear. Its nerve is the posterior auricular.

THE DEEP MUSCLES OF THE BACK.

DISSECTION.—The upper portion of the posterior triangle of the neck should now be defined and the cervical portion of the trapezius cleaned. The posterior divisions of the third, fourth and fifth cervical nerves which pierce the cervical origin of the trapezius to supply the skin over it should be secured. The sides of the posterior triangle are formed by the trapezius and sternomastoid muscles. The semispinalis capitis, the splenius capitis and the levator scapulae muscles which constitute the upper part of its floor will likewise be exposed. Take care to secure the accessory nerve and the twigs from the third and fourth cervical nerves which accompany one another obliquely across the floor. The trapezius will then be reflected in order to assist the dissector of the upper limb to trace these nerves to their distribution. The serratus superior which passes from the vertebral spines to the upper four ribs may now be severed and the splenius muscle defined.

The splenius arises from the upper four or five dorsal spines and from the ligamentum nuchae. It divides into the splenius cervicis and the splenius capitis, of which the former is inserted into the upper three or four cervical transverse processes under cover of the levator scapulae, while the splenius capitis crosses the floor of the posterior triangle to obtain insertion into the mastoid process and the outer end of the superior curved occipital line under cover of the sterno-mastoid. Its nerve supply is from the posterior divisions of the cervical and dorsal spinal nerves and its chief action is to rotate the head and neck to the same side.

DISSECTION.—Reflect the splenius from its origin and commence the definition of the erector spinae muscle. Sever the aponeurosis of the latissimus dorsi and serratus inferior which covers the lower end of this, and note that the serratus inferior is a scanty muscle inserted into the lower four ribs. The lumbar aponeurosis should also be studied at this stage.

The lumbar aponeurosis consists of three lamellae which enclose between them the erector spinae posteriorly and the quadratus lumborum anteriorly. Therefore on lifting up the lower end of the erector spinae the middle lamella will be found intervening between it and the quadratus lumborum. The posterior lamella is composed of the fused aponeuroses of the latissimus dorsi and serratus inferior muscles, and is attached to the lumbar spines, to the back of the sacrum and to the posterior third of the iliac crest. The middle lamella is attached to the transverse processes of the lumbar vertebrae, while the anterior lamella, which has been already studied in the abdominal cavity, is attached to the bodies of the lumbar vertebrae.

The erector spinae will only be described in outline. Its origin is from the lower dorsal spines, the lumbar spines, the back of the sacrum and the posterior third of the iliac crest. The muscle divides into inner, middle and outer columns. The lower end of the outer column is aptly named the ilio-costalis as it is inserted into the lower ribs at their angles. If this outer column be traced upwards it will be noted that it is continued as the costalis dorsi which passes from the lower to the upper ribs at their angles, and is in its turn prolonged into the cervical region as the costalis cervicis which passes from the upper ribs to the transverse processes of the cervical vertebrae.

The middle column passes upwards into the dorsal region as the longissimus dorsi and is attached to the ribs. It is continued upwards into the neck as the longissimus cervicis which passes to the transverse processes of the lower cervical vertebrae, and is in its turn prolonged upwards to the mastoid process as the longissimus capitis.

The inner column of the erector spinae is termed the spinalis dorsi. It does not extend beyond the dorsal region and is inserted into the vertebral spines.

DISSECTION.—Remove the erector spinae in order to expose the semispinalis group.

The semispinalis dorsi and semispinalis cervicis pass from the transverse processes to the spines in the dorsal and cervical regions. The fibres cross several vertebrae, but a deeper group of fibres passes from the transverse processes to the spines of neighbouring vertebrae and has been termed the multifidus spinae.

The semispinalis capitis is an important muscle. It arises from the upper six dorsal transverse processes and also from the lower cervical vertebrae. It is inserted into the oval area between the superior and inferior occipital curved lines.

The deepest layers of the back muscles consist of the intertransverse muscles, the rotatores spinae and the levatores costarum.

All the muscles of the back that have just been described are supplied by the posterior divisions of the spinal nerves in their respective regions.

DISSECTION.—Reflect the semispinalis capitis from its insertion in order to expose the suboccipital triangle. In doing so take care to disengage the great occipital nerve from the muscle.

THE SUBOCCIPITAL TRIANGLE.

This space might be described as a three-sided box with three lids and three contents. Its inner side is formed by the rectus capitis posterior major, its upper and outer side by the obliquus superior muscle, and its lower and outer side by the obliquus inferior. The three lids are the semi-spinalis capitis, the splenius capitis, and the trapezius. The three contents are the posterior arch of the atlas, on which rests the vertebral artery, while the posterior division of the first cervical nerve emerges between the two.

The rectus capitis posterior major arises from the spine of the axis and is inserted into the middle third of the inferior occipital curved line. The obliquus inferior also takes origin from the spine of the axis. It is directed upwards and outwards to the transverse process of the atlas. The obliquus superior arises from the transverse process of the atlas and is inserted into the outer third of the inferior occipital curved line. At this stage look for the rectus capitis posterior minor which passes from the tubercle on the posterior arch of the atlas to the inner third of the inferior occipital curved line. All these muscles are innervated by the posterior division of the first cervical nerve.

DISSECTION.—The body is now turned again on its back, and the skin removed from the remainder of the neck. The superficial fascia is now gently scraped off the platysma muscle, and after noting how extensive a sheet it forms in the superficial fascia, remove it in order to expose the cutaneous nerves of the neck which appear at the middle of the posterior border of the sterno-mastoid. Secure also the external jugular vein which runs downwards to join the subclavian vein and the anterior jugular vein which lies by the side of the middle line of the neck.

THE CUTANEOUS NERVES OF THE NECK.

The cutaneous nerves of the neck appear at the middle of the posterior border of the sterno-mastoid. Of these the small occipital and the great auricular have been previously studied. The descending cutaneous stem is very prominent. It divides into outer, middle and inner branches which stream downwards over the clavicle, and supply the skin of the lower part of the front of the neck and the upper portion of the pectoral region. The transverse cutaneous nerve of the neck sweeps forwards round the posterior border of the sterno-mastoid and divides into upper and lower branches which supply the skin over the anterior triangle of the neck.

THE POSTERIOR TRIANGLE OF THE NECK.

The posterior triangle curves obliquely round the lateral aspect of the neck. It is bounded in front by the sterno-mastoid and behind by the trapezius, while its base is formed by the middle third of the clavicle. Its truncated apex is formed by a small portion of the superior occipital curved line. The floor is formed from above downwards by a small piece of the semispinalis capitis, the splenius capitis, the levator scapulae, the scalenus medius and posterior, and the first rib with the first digitation of the serratus magnus. The roof is formed by the cervical fascia. The contents are (1) Arteries—the third part of the subclavian the transverse cervical, the suprascapular, the occipital; (2) Veins accompanying the above; and also the external jugular vein; (3) Nerves—the accessory nerve and also numerous branches of the cervical and brachial plexuses, (4) Lymph glands and vessels.

The third part of the subclavian artery lies in the base of the triangle, and just above it the suprascapular and transverse cervical arteries cross the triangle. The occipital artery crosses the apex of the triangle. All these contents will be studied later.

The posterior triangle is divided into an upper occipital and a lower supra-clavicular portion by the posterior belly of the omo-hyoid muscle which crosses it just above the clavicle.

The sterno-mastoid arises from the anterior aspect of the manubrium sterni and from the inner third of the upper aspect of the clavicle. It is directed upwards and backwards to its insertion into the outer aspect of the mastoid process and the outer half of the superior occipital curved line. Its innervation is from the accessory nerve and the second cervical nerve. Its action is to rotate the head to the opposite side. It is also a muscle of extraordinary respiration. It is a very important landmark in the neck and separates the posterior from the anterior triangle.

THE ANTERIOR TRIANGLE OF THE NECK.

The base of the anterior triangle is above and is formed by the lower border of the mandible. One side is formed by the middle line of the neck and the other by the sterno-mastoid. The roof is formed by the cervical fascia. It is subdivided into three subsidiary triangles as follows: The submaxillary or digastric triangle is bounded by the lower border of the mandible and the two bellies of the digastric muscle, the posterior belly being supplemented by the stylo-hyoid muscle. The carotid triangle is bounded by the sterno-mastoid, the anterior belly of the omo-hyoid and the posterior belly of the digastric muscle. The muscular triangle is mapped off by the middle line of the neck, the sterno-mastoid and the anterior belly of the omo-hyoid. This triangle possesses a floor formed by the sterno-hyoid and sterno-thyroid muscles which will also have to be defined at this stage.

The posterior belly of the digastric muscle arises from the digastric fossa on the under aspect of the mastoid-temporal bone, while the anterior belly takes origin from the digastric fossa on the under aspect of the mandible by the side of the symphysis. The intermediate tendon of the muscle is bound down to the hyoid bone by a sling of fascia. The posterior belly is innervated by the facial or seventh cranial nerve and the anterior belly by the trigeminal or fifth cranial nerve. The action of the muscle is to open the mouth.

The stylo-hyoid muscle arises from the posterior aspect of the root of the styloid process. It runs along the upper edge of the posterior belly of the digastric muscle and is inserted into the body of the hyoid bone by two slips which enclose the intermediate tendon of that muscle between them. Its nerve supply is from the facial, and its action is to elevate the hyoid bone.

THE DEPRESSOR MUSCLES OF THE HYOID BONE.

The posterior belly of the omo-hyoid arises from the upper border of the scapula and from the suprascapular ligament. It crosses the posterior triangle and its intermediate tendon is held in place behind the sterno-mastoid by a special sling of cervical fascia. The anterior belly lies in the anterior triangle and obtains insertion into the lower border of the hyoid bone. This muscle is supplied by the ansa hypoglossi. It is one of the depressor muscles of the hyoid bone.

The sterno hyoid arises from the posterior aspects of the manubrium sterni and the inner end of the clavicle. Its insertion is into the lower border of the body of the hyoid bone between the omo-hyoid and the middle line. Its action and nerve supply are the same as those of the omo-hyoid.

The sterno-thyroid obtains origin from the posterior aspects of the manubrium sterni and the first costal cartilage. It is inserted into the oblique line on the ala of the thyroid, from which it is continued up to the hyoid as the thyro-hyoid. The latter muscle is inserted into the lower border of the body of that bone under cover of the omo-hyoid and sterno-hyoid. It differs from the other three depressor muscles of the hyoid in obtaining its nerve supply directly from the trunk of the hypoglossal nerve.

THE CERVICAL FASCIA.

As the deep fascia of the neck has been already disturbed to a considerable degree in exposing the triangles of the neck, it is advisable to study it now. In the middle line posteriorly it is attached to the ligamentum nuchae. When traced forwards it gives a sheath to both surfaces of the trapezius, and then crosses the posterior triangle, the muscles on the floor of which it invests completely. It furnishes sheaths to both surfaces of the sterno-mastoid and then sweeps forwards to cover the muscles in the anterior triangle. At the middle line of the neck it becomes continuous with the deep cervical fascia from the opposite side. Superiorly from before backwards it is attached to the lower obrder of the mandible. Behind the angle of the jaw it is continuous above with

the parotid fascia as previously shown. Still further back it obtains attachment to the external ear, to the base of the mastoid process and to the superior occipital curved line. Its inferior attachments from before backwards are to the upper border of the manubrium sterni, the clavicle, the acromion process and the spine of the scapula. It is attached to the upper border of the manubrium sterni in two lamellae, between which a small vein connecting the lower ends of the anterior jugular veins, and one or two lymphatic glands may be found.

Two important partitions of fascia sweep across from side to side between the layers of the neck. These are the prevertebral and the pretracheal layers of cervical fascia.

The prevertebral layer is really the anterior sheath for the prevertebral muscles namely—the longus colli the rectus capitis anterior major and minor and the scalenus anterior. Below, it therefore ends on the upper two or three dorsal vertebrae at the lowest limit of the longus colli and is attached above to the basi-occipital bone. On each side it is attached to the fascia on the deep surface of the sterno-mastoid.

The pre-tracheal layer is the posterior sheath for the depressor muscles of the hyoid bone. Therefore it ends above on the hyoid bone and is attached below to the back of the sternum at the lowest limits of the sterno-hyoid and sterno-thyroid muscles. On each side it obtains attachment to the fascia on the deep aspect of the sterno-mastoid. Its deep surface is firmly attached to the capsule of the thyroid gland.

The space on each side of the neck that is bounded in front by the pretracheal fascia, behind by the prevertebral fascia, externally by the fascia on the deep surface of the sterno-mastoid and internally by the connective tissue sheaths of the trachea, oesophagus and thyroid gland is occupied by an aggregation of areolar tissue in which the carotid vessels, the internal jugular vein, and certain nerves are imbedded, and is thus known as the carotid sheath.

The contents of the carotid sheath are—(1) the common carotid artery and its two terminal branches, the external and internal carotid; (2) to the outer side of these is the internal jugular vein; (3) the cervical sympathetic cord lies directly behind the common and internal carotid arteries; (4) the vagus nerve lies between the carotids and the internal jugular vein, but on a more posterior level; (5) The descendens hypoglossi nerve and the ansa hypoglossi lie in front of the common carotid artery.

DISSECTION.—Open up the lower part of the carotid sheath and define its contents. At the same time expose the course and relations of the common carotid artery.

THE COMMON CAROTID ARTERY.

The common carotid artery arises on the right side behind the sterno-clavicular joint as the larger terminal branch of the innominate artery. The left common carotid artery springs directly from the arch of the aorta, and enters the root of the neck behind the left sterno-clavicular joint. The course of all

three carotid arteries is indicated by a line drawn from the inner end of the clavicle to the lobule of the ear, which follows approximately the anterior border of the sterno-mastoid muscle. The common carotid artery terminates opposite the upper border of the thyroid cartilage by dividing into the external and internal carotid arteries.

The relations of the common carotid artery are as follows. In front it is covered by the skin, superficial fascia, platysma, and deep fascia and is, moreover, overlapped throughout its course by the anterior border of the sterno-mastoid muscle. At its commencement it is overlapped by the origins of the sterno-hyoid and sterno-thyroid muscles and is crossed higher up by the anterior belly of the omo-hyoid. The superior and middle thyroid veins pass in front of it to join the internal jugular, while a small muscular branch to the sterno-mastoid from the superior thyroid artery likewise crosses in front of it. Running downwards in front of the vessel is the descendens hypoglossi nerve which forms the ansa lower down. Posteriorly, the common carotid artery is in relation to the transverse processes of the lower cervical vertebrae, but is separated from these by the prevertebral muscles, the prevertebral fascia, and the cervical sympathetic cord which runs downwards directly behind the artery. The inferior thyroid artery will be found passing transversely inwards behind it at the level of the sixth cervical vertebra. In addition, the right recurrent laryngeal nerve passes upwards and inwards behind the right common carotid artery, while the thoracic duct arches outwards behind the left common carotid. The internal relations of the artery are at first the trachea and oesophagus, and higher up the larynx and pharynx. Running upwards in the groove between the trachea and the oesophagus is the recurrent laryngeal nerve. The lateral lobe of the thyroid gland is also an internal relation and frequently overlaps the artery in front. To the outer side of the artery is the internal jugular vein which overlaps it to some extent especially on the left side. Between and behind the two great vessels lies the vagus nerve. Note once more that the common carotid artery is enclosed throughout its course in the carotid sheath. It has no branches apart from its terminal arteries.

DISSECTION.—The sterno-mastoid is now to be reflected from its origin and turned upwards. Then detach the sterno-hyoid and sterno-thyroid muscles from their origins also, taking care not to injure the anterior jugular vein which passes outwards in front of them. On pushing aside the lower end of the internal jugular vein and the vagus nerve the first part of the subclavian artery will be exposed. Define its branches.

THE SUBCLAVIAN ARTERY.

The subclavian artery arises on the right side behind the sterno-clavicular articulation as the smaller terminal branch of the innominate artery. On the left side it springs directly from the aortic arch and reaches the root of the neck behind the left sterno-clavicular joint. The course of the artery is indicated on the surface by a curved line passing from the inner end to the centre of the

clavicle and arching half an inch above it. The artery changes name into axillary at the outer border of the first rib. The subclavian artery is divided by the scalenus anterior into three parts for convenience in description, the first part being to the inner side of this muscle, the second part behind it and the third part beyond it. Before studying the relations it may be noted that one nerve and at least one vein lie in front of each part of the artery.

In front of the first part are the skin, superficial fascia, platysma, deep fascia, the sterno-mastoid and the sterno-hyoid, and sterno-thyroid muscles, between which and the sterno-mastoid lies the anterior jugular vein. In front also are the internal jugular and vertebral veins, the vagus nerve and a few minute cardiac twigs. Below and behind, the first part is in relation to the groove on the apex of the lung with the cervical pleura and a special layer of fascia intervening. The cervical sympathetic is further back but often sends a loop around the first part of the artery. In addition, on the right side the right recurrent laryngeal nerve hooks round it, while on the left side the thoracic duct arches downwards in front of it in order to enter at the point of junction of the internal jugular and subclavian veins.

The second part of the subclavian artery is crossed in front by the scalenus anterior which separates it from the phrenic nerve and the subclavian vein. Anterior to these, again, are the sterno-mastoid muscle and the superficial layers of the neck. It should be noted that on the left side the phrenic nerve runs downwards along the inner edge of the scalenus anterior. Below and behind, the second part of the subclavian artery is in relation to the apex of the lung and pleura, just like the first part.

The third part of the subclavian artery is situated in the posterior triangle of the neck. Therefore at first it is covered merely by the skin, superficial fascia, platysma and deep fascia, but at its termination it dips behind the clavicle and the subclavius muscle. It is also crossed in front by the nerve to the subclavius and by the external jugular vein on its way to join the subclavian vein which is below and in front of the artery. The suprascapular and transverse cervical arteries and veins and the posterior belly of the omohyoid which lie in the basal portion of the posterior triangle must also be considered as anterior relations. Posteriorly the artery is in relation to the scalenus medius, the lowest trunk of the brachial plexus, however, intervening between the two. Inferiorly the artery rests in the groove on the upper surface of the first rib, while above it are the upper and middle trunks of the brachial plexus.

THE BRANCHES OF THE SUBCLAVIAN ARTERY.

The branches of the subclavian artery are as follows: From the first part are given off the vertebral, the thyroid axis and the internal mammary arteries; and from the second part the superior intercostal artery. The posterior scapular branch of the thyroid axis may arise separately from the third part.

The vertebral artery is the first branch of the first part, and arises from its postero-superior aspect. It is directed upwards, and after a brief course enters the foramen in the transverse process of the sixth cervical vertebra. It traverses the upper six foramina with its vein which lies in front, and then curves backwards and inwards in the groove on the upper surface of the posterior arch of the atlas, where we previously saw it in the suboccipital triangle. It disappears through the posterior occipito-atlantal ligament and the dura mater and enters the spinal canal and skull, where it will be studied later. In the extracranial portion of its course it supplies spinal twigs to the spinal cord and its membranes, and twigs to the prevertebral muscles.

The thyroid axis artery arises from the anterior aspect of the subclavian close to the inner border of the scalenus anterior muscle, and almost immediately divides into the inferior thyroid, transverse cervical and suprascapular arteries.

The inferior thyroid artery runs upwards along the inner border of the scalenus anterior muscle, and then bends inwards behind the common carotid artery at the level of the sixth cervical vertebra in order to reach the thyroid gland and divides into anterior and posterior branches which supply the corresponding aspects of the gland, and also anastomose with the superior thyroid artery. The inferior thyroid also supplies twigs to the trachea, to the oesophagus, to the prevertebral muscles, and the inferior laryngeal artery .which accompanies the recurrent laryngeal nerve to the larynx. In addition, the ascending cervical artery is given off from the bend of the vessel, and is distributed to the prevertebral muscles.

The transverse cervical and suprascapular arteries run outwards in front of the scalenus anterior and the phrenic nerve, and after crossing the basal portion of the posterior triangle, disappear under the trapezius muscle from which point their further course has been already studied in the upper limb. The transverse cervical divides into superficial and deep (posterior scapular) branches at the outer border of the levator scapulae. The suprascapular artery accompanies the corresponding nerve to the upper border of the scapula, but it passes over the suprascapular ligament while the nerve passes under. Its distribution to the supra and infra spinatus muscles and to the scapular anastomoses has been already studied.

The internal mammary artery takes origin from the under aspect of the first part of the subclavian opposite the thyroid axis. It runs downwards behind the clavicle, and enters the thorax behind the first costal cartilage. Note that the phrenic nerve sweeps round the anterior aspect of the artery in this part of its course. Its further distribution in the thorax has been already studied.

The superior intercostal artery takes origin from the posterior aspect of the second part of the subclavian. It arches backwards over the lung and pleura to reach the neck of the first rib in front of which it enters the thorax just external to the sympathetic cord. It terminates by dividing into two branches which supply the first two intercostal spaces. Just before entering the thorax it sends backwards the profunda cervicis artery above the neck of the first rib.

This vessel runs upwards under the semi-spinalis capitis to anastomose with the princeps cervicis branch from the occipital artery, and also supplies the deep muscles of the neck.

DISSECTION.—As the clavicle will have to be removed in order to obtain a satisfactory view of the subclavian vein, it will be necessary to examine the subclavius muscle, which arises from the upper aspect of the first rib close to its sternal end, and is directed upwards and outwards to be inserted into the groove on the under aspect of the middle third of the clavicle Its nerve is derived from the upper trunk of the brachial plexus and its action is to depress the clavicle.

The subclavian vein begins at the outer border of the first rib as the continuation of the axillary vein. It runs inwards in the groove on the upper surface of the first rib in front of the insertion of the scalenus anterior at the inner border of which it ends by joining the internal jugular to form the innominate vein. It is situated below and in front of the subclavian artery and moreover, is separated from the second part by the scalenus anterior and the phrenic nerve. It is a peculiar fact that the subclavian vein as a rule receives no tributaries corresponding to the branches of the artery. The only tributary is the external jugular vein, which in its turn is joined close to its termination by the transverse cervical, suprascapular and anterior jugular veins. The latter may however, join the subclavian directly.

THE CERVICAL PLEXUS.

This plexus lies under cover of the upper half of the sterno-mastoid muscle. Nearly all its branches have been already exposed. It is formed by the anterior divisions of the first four cervical nerves, which are connected together by loops. The fourth also sends down a communicating branch to the brachial plexus. The branches of the plexus are arranged as follows—the first cervical nerve gives off two sets of branches, the second cervical nerve gives off two branches, the second and third cervical give off conjointly three branches, and the third and fourth cervical give off conjointly three sets of branches.

The branches from the first cervical are to the recti group of muscles (the rectus capitis anterior major and minor, and the rectus lateralis) and a communicating branch to the hypoglossal nerve at the base of the skull.

The branches from the second cervical nerve are to the sterno-mastoid, and the small occipital nerve which runs upwards along the posterior border of the sterno-mastoid muscle to supply the scalp as already described.

The branches given off conjointly from the second and third cervical are the great auricular, the transverse cutaneous nerve of the neck, and the communicating nerve to the ansa hypoglossi. The first two have been already described, while the latter curves downwards over the internal jugular vein to join the ansa hypoglossi in front of the common carotid artery.

The branches furnished conjointly by the third and fourth cervical nerves are the descending cutaneous trunk, the twigs to the trapezius and levator scapulae, and the upper two roots of the phrenic nerve. All these have been already

described except the phrenic nerve which runs downwards, and may receive a third root from the fifth cervical nerve. The phrenic nerve has a characteristic course in front of the scalenus anterior and behind the subclavian vein. It enters the thorax after curving round the anterior aspect of the internal mammary artery just below its origin. Its further course in the thorax has been studied previously.

In addition to these branches it should be noted that the first four cervical nerves communicate with the superior cervical ganglion of the sympathetic.

THE BRACHIAL PLEXUS.

This plexus is formed by the fifth, sixth, seventh and eighth cervical nerves and the first dorsal nerve. In addition the fifth cervical receives a small branch from the fourth while the first dorsal nerve is joined by a twig from the second. From these nerves three trunks are formed as follows. The fifth and sixth cervical unite to form the upper trunk, the seventh cervical nerve is continued as the middle trunk, and the eighth cervical and first dorsal nerves join to form the lower trunk. These three trunks appear along with the subclavian artery between the scalenus anterior and scalenus medius. Each trunk then divides into anterior and posterior divisions of which the three posterior divisions unite to form the posterior cord, the two upper anterior divisions join to form the external cord and the lower anterior division is continued as the inner cord. Note that the latter cord though formed only from one trunk is larger than the external, owing to the fact that it receives nearly the whole of the lower trunk, whose posterior division is very small. The three cords of the brachial plexus and their branches have been previously studied in the axilla. Certain branches, however, spring from the earlier stages of the plexus, and are known as the supraclavicular group. These branches take origin as follows—

(1) Two nerves arise from the 5th cervical.

(2) Two nerves arise from the 5th and 6th cervical.

(3) One nerve arises from the 5th, 6th and 7th cervical.

(4) One set of nerves arises from the 5th, 6th, 7th and 8th cervical.

(5) One set of nerves arises from the 5th, 6th, 7th and 8th cervical and 1st dorsal nerves.

The two nerves taking origin from the fifth cervical are the lower root of the phrenic nerve, and the nerve to the rhomboids, which pierces the scalenus medius. Its distribution to the levator scapulae and rhomboid muscles has been already studied.

The two nerves from the fifth and sixth cervical are the suprascapular and the nerve to the subclavius and they take origin from the upper trunk. The suprascapular nerve is the largest of this group and passes backwards and outwards to reach the suprascapular foramen. It supplies the supra and infraspinatus muscles and articular twigs to the shoulder joint. The nerve to the subclavius has been already examined as an anterior relation of the third part of the subclavian artery.

The branch from the fifth, sixth and seventh cervical nerves is the nerve to the serratus magnus. Note that its upper two roots pierce the scalenus medius. Its further course in the axilla has been previously examined.

The set of nerves from the fifth, sixth, seventh and eighth cervical nerves supplies the three scalene muscles.

The fifth, sixth, seventh and eighth cervical nerves and the first dorsal nerve furnish a set of communicating nerves to the ganglia of the sympathetic.

THE SCALENE MUSCLES.

The scalenus anterior takes origin from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebrae. The muscle is directed downwards and slightly outwards to its insertion into the scalene tubercle and the triangular area on the upper surface of the first rib between the subclavian grooves. Its innervation is from the lower cervical nerves and its action is that of a muscle of extra-ordinary respiration.

The scalenus medius and posterior have a common origin from the posterior tubercles of the transverse processes of the cervical vertebrae. The fibres of the scalenus medius are inserted into an oval rough area on the upper surface of the first rib between the groove for the subclavian artery and the tubercle of the rib. The scalenus posterior is defined as the bundle of fibres which passes downwards to be inserted into the outer aspect of the second rib. The nerve supply and action of these scalene muscles are the same as those of the scalenus anterior.

THE TEMPORAL AND PTERYGO-MAXILLARY REGIONS.

The exploration of these regions is simply the dissection of the temporal and zygomatic fossae of the skull, which therefore ought to be studied first of all. The two layers of the temporal fascia must then be removed in order to expose the origin of the muscle. The masseter is to be defined at the same time.

The temporal fascia is strongly developed and consists of two strata with a layer of adipose tissue between. It is attached above to the upper temporal line of the parietal and to the temporal ridge of the frontal bone. Anteriorly it obtains attachment to the posterior border of the malar bone, below to the upper border of the zygomatic arch and behind to the supramastoid crest of the temporal bone.

The masseter muscle obtains origin from the lower border and the inner surface of the zygomatic arch. Note that its superficial fibres run downwards and backwards, while the deeper strata are directed downwards and forwards. The muscle is inserted into the angle and the whole of the outer surface of the ascending ramus of the mandible. Its nerve supply is from the third division (trigeminal) nerve and its action is to elevate the jaw in mastication.

DISSECTION.—The zygomatic arch has to be sawn through behind and in front of the origin of the masseter, and turned downwards with the muscle which must be stripped off the ramus of the jaw down to the angle, but not removed.

The temporal muscle is now fully exposed. The cut ends of the masseteric vessels and nerve will be found in the sigmoid notch of the jaw.

The temporal muscle arises from the temporal fossa of the skull as high up as the lower temporal line of the parietal bone. The anterior fibres are vertical in direction, the intermediate fibres show various degrees of obliquity, while the most posterior fibres are directed horizontally forwards. The muscle obtains insertion into the apex, the anterior and posterior borders, and the whole of the inner surface of the coronoid process of the mandible. Its insertion is prolonged downwards along the anterior border of the ramus of the jaw as far as the third molar tooth. The muscle is innervated by the third division of the fifth cranial nerve. The muscle for the most part acts as an elevator of the jaw in mastication; but the posterior fibres are the retractors of the jaw.

DISSECTION.—The ramus of the mandible has now to be sawn horizontally about its middle, taking care not to injure the inferior dental vessels and nerve upon its deep surface. The neck of the jaw is then severed, and the piece thus released is to be turned upwards with the temporal muscle. A little dissection will expose the horizontally directed fibres of the external pteryoid muscle, round which the internal maxillary artery and its branches and the nerves of the space are grouped.

The external pterygoid muscle is the key to the pterygo-maxillary region. For example it divides the internal maxillary artery, which is the artery of the region, into three parts. The first part of the artery runs along its lower border, the second part crosses it either superficially or deeply, and the third part passes between the two heads of origin of the muscle. The third division of the fifth cranial (trigeminal) nerve likewise distributes its branches round the external pterygoid muscle in a characteristic manner. At the lower border the lingual and inferior dental nerves will be secured, while at the upper border of the muscle are found the nerves to the masseter and temporal muscles. The long buccal nerve appears between the two heads of the muscle and the auriculo-temporal nerve winds round its insertion into the neck of the jaw in order to reach the temporal region of the scalp.

The external pterygoid muscle arises by two heads of which the upper obtains origin from the infra-temporal crest on the great wing of the sphenoid bone, while the lower head arises from the outer surface of the external pterygoid plate. The muscle is directed horizontally backwards to its insertion into the special fossa on the anterior aspect of the neck of the jaw, and into the meniscus of the temporo-maxillary joint. It is innervated by the third division of the fifth cranial nerve, and its action is to protract the jaw in mastication.

The internal pterygoid muscle encloses the lower head of the external pterygoid by means of its superficial and deep heads. The superficial head arises from the tuberosity of the superior maxilla and from the tuberosity of the palate bone as it appears in the zygomatic fossa of the skull. The deep head obtains origin from the inner surface of the external pterygoid plate and from the tuberosity of the palate bone, as it appears in the pterygoid fossa of the skull. The muscle fibres are directed downwards and backwards to their insertion into

the angle of the mandible and into a rough triangular area between this and the mylo-hyoid groove on the deep surface of the ramus. It is supplied by the third division of the fifth cranial nerve, and its action is to elevate the jaw in mastication.

THE INTERNAL MAXILLARY ARTERY.

This artery is the larger terminal branch of the external carotid artery and takes origin in the substance of the parotid gland behind the neck of the jaw. The first part of the artery is directed forwards on the deep aspect of the neck of the jaw and then along the lower border of the external pterygoid muscle. The spheno-mandibular ligament lies to the inner side of the first part. The second part crosses the external pterygoid muscle either superficially or deeply, while the third part of the artery passes between the heads of the external pterygoid and disappears into the spheno-maxillary fossa through the pterygo-maxillary fissure. The third part ends by dividing into six terminal branches. The internal maxillary vein forms a dense plexus round the artery and a terminal stem joins the superficial temporal vein in the substance of the parotid gland to form the temporo-maxillary vein.

The branches of the internal maxillary artery are very numerous. It may be noted that the branches from the first and third parts pass through bony canals while those from the second part go to muscles.

The branches of the first part are—

(1) the deep auricular,
(2) the tympanic,
(3) the middle meningeal,
(4) the small meningeal,
(5) the inferior dental.

The deep auricular artery pierces the wall of the external auditory meatus between the bone and the cartilage, and is its vessel of supply.

The tympanic artery passes upwards behind the head of the mandible and enters the tympanum through the petro-tympanic fissure. It supplies the tympanum, the mastoid antrum and the mastoid air cells.

The middle meningeal artery proceeds upwards under cover of the external pterygoid muscle and enters the skull through the foramen spinosum. It divides into anterior and posterior branches which groove the parietal bone deeply and supply the dura mater or outer membrane of the brain.

The small middle meningeal artery passes into the skull through the foramen ovale and is distributed to the dura mater.

The inferior dental artery is the only branch of the first part of the internal maxillary that is directed downwards. It lies behind the corresponding nerve and the two enter the inferior dental foramen in order to supply the lower teeth. The mandibular canal in which they lie ought to be opened up to expose them. The main stem of the artery supplies the three molar and the two premolar teeth. It then divides into an incisor branch which supplies the canine tooth and the two

incisors and also anastomoses with its fellow; and a mental branch which emerges on to the face through the mental foramen. It supplies the tissues over the chin and anastomoses with the facial artery. Just before entering the inferior dental foramen the inferior dental artery and nerve give off the mylo-hyoid vessels and nerve which groove the mandible just below the foramen and supply the muscle of that name.

The muscular branches furnished by the second part of the internal maxillary artery supply the masseter, external and internal pterygoid, buccinator and temporal muscles. The branches to the latter muscle are two in number and are termed the deep temporal arteries. They run upwards between the muscle and the cranial wall.

The branches of the third part of the artery will not all be seen at present but a little dissection of the spheno-maxillary fossa with the forceps will expose at least three of them. All six pass through bony canals and are moreover, named after these.

The posterior superior dental artery is readily found. It runs downwards on the posterior surface of the superior maxilla in order to enter the posterior superior dental canal which conveys it to the supply of the three upper molars and the two upper premolar teeth. It also supplies the mucous membrane of the maxillary antrum.

The infra-orbital branch enters the orbit through the spheno-maxillary fissure and then runs forward in the infra-orbital groove on the floor of the orbit. This groove rapidly deepens until it becomes the infraorbital canal which opens on to the face at the infra-orbital foramen. The artery supplies the tissues of the face and anastomoses with the facial artery. It also gives off the anterior superior dental artery which runs downwards in a minute bony canal on the anterior wall of the maxillary antrum to supply the two upper incisors and the canine tooth. It likewise furnishes twigs to the mucous membrane of the maxillary antrum.

The descending or posterior palatine artery runs downwards in the posterior palatine canal to supply the tissues of the hard and soft palates.

The Vidian and pterygo-palatine arteries run backwards in the bony canals of the same name in order to supply the roof of the pharynx and the Eustachian tube.

The spheno-palatine artery enters the nasal fossa through the foramen of the same name. Its distribution will have to be studied later.

DISSECTION.—Disarticulate the head of the jaw and turn it forwards along with the external pterygoid muscle in order to expose the third division of the fifth cranial nerve.

THE THIRD DIVISION OF THE FIFTH CRANIAL NERVE.

The third division of the trigeminal or fifth cranial nerve is the only one that contains motor fibres. The sensory portion arises as usual from the Gasserian ganglion and is joined by the motor root of the fifth nerve. The completed

nerve leaves the base of the skull through the foramen ovale and almost immediately divides into anterior and posterior branches. The trunk gives off a recurrent twig to the dura mater and the nerve to the internal pterygoid muscle, on which is the minute otic ganglion. The latter gives off the nerves to the tensor palati and the tensor tympani, and a communicating twig to the auriculo-temporal nerve. It also receives the small superficial petrosal nerve which brings it into communication with the ninth cranial nerve.

The anterior branch of the third division of the fifth nerve gives off the nerve to the external pterygoid which at once sinks into the deep surface of that muscle, the nerves to the masseter and temporal muscles; and the long buccal nerve which is its only sensory offshoot. The nerve to the masseter and the two nerves to the temporal muscle appear at the upper border of the external pterygoid, the latter nerves being the more anterior. The long buccal nerve passes forwards between the two heads of the external pterygoid muscle and emerges on to the face from under cover of the masseter muscle. Its distribution to the skin and mucous membrane of the cheek has been already studied.

In contrast to the preceding the posterior branch of the third division of the fifth nerve is mainly sensory. It gives off three branches—the auriculo-temporal, the lingual and the inferior dental. The auriculo-temporal arises by two rootlets which enclose between them the middle meningeal artery. The nerve sweeps backwards round the neck of the jaw and then turns upwards over the root of the zygoma and in front of the ear in company with the superficial temporal artery on the posterior aspect of which it lies. It has been already shown to end by supplying the external ear and the temporal region of the scalp. It also gives off an articular twig to the temporo-mandibular joint, and receives a communicating twig from the otic ganglion which, however, appears to come off again as the secretory branch to the parotid gland.

After giving off the auriculo-temporal nerve the posterior branch of the third division of the fifth cranial nerve divides into the lingual and inferior dental branches. The former proceeds downwards and forwards between the ramus of the jaw and the internal pterygoid muscle in order to reach the submaxillary region where it will be studied subsequently. In the meantime note that the nerve in this part of its course is joined at an acute angle by the chorda tympani branch of the facial nerve which emerges through the petro-tympanic fissure. Note further that as the lingual nerve enters the submaxillary region it lies in close contact with the inner surface of the jaw immediately below the last molar tooth, and is covered therefore by the mucous membrance of the gums only. It is thus apt to be injured in a clumsy extraction of the last molar tooth.

The inferior dental nerve proceeds downwards in front of the inferior dental vessels in order to enter the inferior dental foramen. It runs forwards in the mandibular canal and has the same distribution as the artery. Thus the trunk supplies the three molars, the two premolars, and then divides into incisor and mental branches. The former supplies the canine tooth and the two incisors, while the mental nerve emerges on to the chin through the foramen of that name. Its distribution to the skin of the chin has been already examined. Just before

entering the inferior dental foramen, the nerve gives off the branch to the mylo-hyoid, which represents the only motor fibres of the posterior branch of the third division of the fifth cranial nerve. The mylo-hyoid nerve runs downwards with the vessels in the groove of the same name, and ends by supplying this muscle and the anterior belly of the digastric muscle.

THE SUBMAXILLARY REGION.

DISSECTION.—Cut the facial artery as it emerges on to the face, and pull backwards the submaxillary gland in which the lower portion of the artery is imbedded, so as to expose the submaxillary region. After doing so the submental branch of the facial artery will be uncovered as it ramifies under the chin. This artery will have to be sacrificed. Reflect the anterior belly of the digastric muscle and turn it downwards in order to display the mylo-hyoid muscle and its nerve.

The mylo-hyoid muscle takes origin from the mylo-hyoid ridge on the inner surface of the mandible. The fibres run downwards and inwards to be inserted into the upper and anterior aspects of the body of the hyoid bone, but the most anterior portion of the muscle meets its fellow in a mesial raphe which extends upwards from the body of the hyoid. The muscle is supplied by the third division of the fifth cranial nerve. Its action is to support the floor of the mouth along with its fellow in mastication.

DISSECTION.—It is best to reflect both mylo-hyoid muscles is one piece which is to be turned down from the origin. A little cleaning up with the forceps will expose the hyoglossus muscle as it passes upwards from the hyoid to the side of the tongue. To facilitate matters it is best to saw through the mandible half an inch from the symphysis and turn it upwards.

The hyoglossus muscle is the key to the submaxillary region, since all the main structures are grouped around it. Note in the first place that it is in relation to the following muscles. Lying along its insertion into the side of the tongue is the stylo-glossus. In front of it will be found the geniohyoid and genio-glossus muscles. Emerging from under cover of its posterior border the middle constrictor muscle of the pharynx will be displayed. Moreover, its anterior half or so is overlapped obliquely from the front by the mylo-hyoid muscle.

Resting upon the superficial surface of the hyoglossus muscle, the following structures will be found from above downwards—

(1) the lingual nerve, hanging from which by two rootlets will be seen the submaxillary ganglion,

(2) the deep portion of the submaxillary salivary gland with the duct,

(3) the chief vein of the tongue,

(4) the hypo-glossal nerve,

Passing under cover of the posterior edge of the muscle from above downwards are—

(1) the glosso-pharyngeal nerve,

(2) the stylo-hyoid ligament,

(3) the first part of the lingual artery.

The third part of the lingual artery will be found running upwards under cover of the anterior border of the hyoglossus, while immediately in front of the upper end of this border is the sublingual salivary gland. It will thus be recognized that the hyoglossus muscle divides the lingual artery into three parts, and that the second part must lie under cover of the muscle.

The hyoglossus takes origin from the upper aspects of the body and great cornu of the hyoid bone. The fibres run upwards to their insertion which is into the lateral aspect of the tongue under cover of the styloglossus. It is innervated by the hypoglossal nerve, and its action is to depress the tongue. A few deep fibres that spring from the lesser cornu of the hyoid bone have been termed the chondro-glossus.

The stylo-glossus arises from the anterior aspect of the styloid process close to its tip. Its insertion is along the lateral aspect of the tongue. Its nerve supply is derived from the hypoglossal and its action is to retract the tongue.

The genio-hyoid obtains origin alongside its fellow from the lower genial tubercle on the posterior aspect of the symphysis of the lower jaw. The muscle is directed downwards and backwards to its insertion into the anterior aspect of the body of the hyoid bone. It is supplied by the hypoglossal nerve. Its action is to depress the jaw, or elevate the hyoid according to the point of origin that is fixed.

The genio-glossus is a fan shaped muscle that arises alongside its fellow from the upper genial tubercle on the posterior aspect of the symphysis of the lower jaw. The fibres diverge rapidly and obtain insertion along the whole length of the under aspect of the tongue where they blend with the intrinsic muscles of the organ. A few of the lower fibres may reach the hyoid bone. The muscle is innervated by the hypoglossal nerve. It is a protractor of the tongue.

The lingual nerve can now be traced to its termination. In the submaxillary region it is directed forwards along the upper border of the hyoglossus muscle, and is then continued forwards along the lateral margin of the tongue underneath the mucous membrane. The lingual nerve supplies the anterior two thirds of the tongue with sensory fibres and (through the chorda tympani nerve) with gustatory fibres. It also gives off the secretory nerve to the sublingual gland, a few twigs to the mucous membrane of the gums and the floor of the mouth, and a loop of communication to the hypoglossal nerve. As the nerve rests upon the hyoglossus it has the minute submaxillary ganglion suspended from it by two rootlets which belong mainly to the chorda tympani fibres of the nerve. The ganglion in its turn will be observed to furnish secretory fibres to the submaxillary gland.

The submaxillary gland consists of superficial and deep portions. The former rests upon the superficial aspect of the mylo-hyoid muscle and therefore forms a prominent object in the digastric triangle. It is covered by the skin, superficial fascia, platysma and deep fascia, but a portion of it lies in a special hollow on the deep aspect of the mandible below the mylo-hyoid ridge. Note that the facial artery lies in a deep furrow in the gland, and furnishes it with its arterial supply. The deep portion of the gland is bent round the posterior border of the mylo-hyoid muscle, and thus comes to lie between it and the hyoglossus. The duct emerges from this portion and is prolonged forwards upon the hyoglossus muscle to reach the floor of the mouth on to which it opens upon the summit of a small papilla by the side of the fraenum of the tongue.

The sublingual is the smallest of the salivary glands. It is in direct contact with the mucous membrane of the floor of the mouth on to which its numerous ducts (at least twelve) open. Its position there is readily recognized by a slight bulging of the mucous membrane between the mandible and the root of the tongue. The inner surface of the gland rests upon the genio-glossus, while its external aspect reclines in a special hollow on the deep surface of the mandible above and in front of the mylo-hyoid ridge. Its posterior extremity reaches the hyoglossus muscle and receives the artery of supply from the lingual.

THE EXTERNAL CAROTID ARTERY.

This vessel is now exposed throughout its whole course and is therefore most conveniently studied at this stage. It arises opposite the upper border of the thyroid cartilage at the level of the fourth cervical vertebra as the smaller terminal branch of the common carotid artery, of which its course is a continuation. It ends in the substance of the parotid gland, behind the neck of the mandible by dividing into the superficial temporal and internal maxillary arteries.

The superficial relations of the external carotid artery are as follows. It is crossed about the middle of its course by the posterior belly of the digastric and the stylo-hyoid muscle. Below this point it is crossed by the hypoglossal nerve, the common facial and the lingual veins and is in addition covered by the sterno-mastoid muscle and the superficial layers of the neck. Above these two muscles it is imbedded in the parotid gland, where it has the temporo-maxillary vein and the facial nerve as superficial relations.

The important deep relation of this artery is the internal carotid artery throughout its whole course except at its origin. Five structures intervene between the two arteries. From above downwards these are—

(1) the deep portion of the parotid gland,
(2) the styloid process,
(3) the stylo-pharyngeus muscle,
(4) the glosso-pharyngeal nerve,
(5) the pharyngeal branches of the vagus. Note that at the origin of the vessel the internal carotid artery lies directly to its outer side and allows it to come into slight relation with the lateral wall of the pharynx at this point.

The branches of the external carotid in addition to its terminal arteries are—

(1) the superior thyroid, the lingual and the facial arteries which arise from its anterior aspect in that order from below upwards;

(2) the occipital and posterior auricular branches which arise from its posterior aspect in that order from below upwards;

(3) the ascending pharyngeal artery which takes origin from its deep aspect.

The superior thyroid springs from the very origin of the external carotid artery and is directed downwards and forwards under cover of the anterior belly of the omo-hyoid in order to reach the thyroid gland where it ends in three terminal branches—one to the posterior aspect of the gland and one to the anterior aspect which anastomose with the inferior thyroid artery. The third terminal branch runs inwards along the upper border of the isthmus of the gland in order to anastomose with its fellow. In addition the superior thyroid artery furnishes the infra-hyoid branch which runs inwards below the level of the hyoid bone to supply the superficial tissues of the neck and anastomose with its fellow; the crico-thyroid branch which is directed inwards along the upper border of the crico-thyroid membrane to supply the adjoining tissues and anastomose with its fellow; the superior laryngeal branch which accompanies the internal laryngeal nerve into the larynx through the thyro-hyoid membrane; and the sterno-mastoid branch which crosses in front of the common carotid artery in order to reach that muscle. Finally the superior thyroid artery supplies muscular twigs to the other muscles in the vicinity.

The lingual artery arises at the level of the hyoid bone and is very tortuous. It forms a marked loop beyond its origin which is crossed superficially by the hypoglossal nerve. This vessel then passes forwards under cover of the posterior belly of the digastric muscle and the stylo-hyoid and then disappears underneath the posterior border of the hyoglossus muscle. This portion constitutes the first part of the artery. Deeply it is in relation to the lateral wall of the pharynx. The second part of the artery is situated on the deep aspect of the hyoglossus muscle about one third of an inch above the level of the hyoid bone. Therefore this portion of the artery must rest upon the middle constrictor muscle of the pharynx and the genio-glossus. The third part of the artery is directed upwards along the anterior border of the hyoglossus and then divides into the artery to the sublingual salivary gland and the terminal artery to the tongue which runs forwards on its under aspect towards the tip and is distributed to its substance. From the first part of the artery is given off the suprahyoid branch which is directed inwards to meet its fellow above the level of the hyoid bone and also supply the tissues in its vicinity The second part of the artery gives off the dorsalis linguae branch which runs upwards under cover of the hyoglossus muscle to supply the sutstance of the tongue.

The chief vein that drains the tongue passes backwards superficial to the hyoglossus. The lingual artery is, in addition, accompanied by venae comites. These veins cross the external carotid artery in order to join the internal jugular vein.

The facial artery arises immediately above the lingual and very often in conjunction with it. The vessel passes upwards and forwards under cover of the posterior belly of the digastric and the stylo-hyoid in order to reach the submaxillary region where it is enclosed in a deep groove in the substance of the submaxillary gland. After escaping from this the artery sweeps upwards over the lower border of the mandible in front of the masseter muscle in order to reach the face, where its subsequent distribution has been previously studied. In the sub-mandibular portion of its course the facial artery gives off its ascending palatine, tonsillar, submaxillary and submental branches. The two former arteries run upwards upon the lateral wall of the pharynx in order to reach their destination. The tonsillar artery pierces the superior constrictor and supplies the tonsil, while the ascending palatine passes over the upper border of this muscle and is conducted to the soft palate along the tensor and levator palati muscles. The submaxillary branches supply the submaxillary gland, and the submental artery has been already observed supplying the tissues underneath the chin. It anastomoses with its fellow of the opposite side.

The occipital artery arises from the posterior aspect of the external carotid at the level of the lower border of the posterior belly of the digastric and runs upwards and backwards along this muscle. The hypoglossal nerve sweeps forwards round the origin of this vessel and at this point gives off its descendens hypoglossi branch. The occipital artery proceeds backwards under cover of the sterno-mastoid, splenius capitis, and longissimus capitis muscles and the mastoid process and in this portion of its course lies in a special groove on the inferior surface of the mastoid temporal bone. The artery then escapes from under cover of these three muscles and crosses the apex of the posterior triangle where it rests upon the semispinalis capitis muscle. Finally it pierces the occipital origin of the trapezius muscle together with the great occipital nerve. The terminal distribution has been already described. In the early portion of its course the occipital gives off numerous muscular branches, of which two have special names. The sterno-mastoid branch accompanies the accessory nerve into that muscle. The other is the princeps cervicis artery which runs downwards under cover of the semispinalis capitis to supply the deep muscles of the neck, and anastomose with the profunda cervicis artery. Two small meningeal branches of the occipital artery which pass through the mastoid and jugular foramina may be found. The sterno-mastoid branch of the occipital artery sometimes rises separately from the external carotid.

The posterior auricular artery takes its origin from the posterior aspect of the external carotid just above the posterior belly of the digastric and runs upwards and backwards between that muscle and the parotid gland. It then passes upwards with the posterior auricular nerve behind the ear and ends in terminal branches to it and to the scalp as already shown. It also supplies the parotid gland, and the stylo-mastoid branch which enters the foramen of the same name in the base of the skull and is distributed to the mastoid antrum and cells and to the facial nerve.

The ascending pharyngeal artery arises from the deep aspect of the external carotid close to its origin and is directed upwards on the side wall of the pharynx towards the base of the skull. It supplies the pharyngeal wall and the prevertebral muscles, and ends in the form of three meningeal arteries which pierce the foramen lacerum medium, the jugular foramen and the hypoglossal canal in order to supply the cerebral meninges.

The superficial temporal and internal maxillary arteries have been already described. Their veins unite to form the temporo-maxillary vein which runs downwards in the parotid gland superficial to the external carotid artery, and soon divides into anterior and posterior branches. The former joins the facial to form the common facial vein which crosses the external carotid artery to enter the internal jugular vein, while the posterior division joins the posterior auricular vein to form the external jugular which runs downwards superficial to the deep fascia of the neck and pierces the roof of the posterior triangle of the neck just above the clavicle in order to join the subclavian vein as previously noted. The posterior external jugular is the name given to a vein which drains the occipital region of the scalp and enters the external jugular vein.

DISSECTION.—Cut the external carotid artery close to its termination and after severing the other branches turn the vessel downwards in order to expose the internal carotid artery and the other chief structures found in the deep dissection of the neck, namely the internal jugular vein, the last four cranial nerves and the sympathetic cord.

THE DEEP DISSECTION OF THE NECK.

The important structures exposed in this dissection have a very characteristic relation to one another. The internal carotid artery and the internal jugular vein will be observed to lie side by side, and at the base of the skull the ninth, tenth, eleventh and twelfth cranial nerves will be found to emerge between them. Of these nerves the tenth or vagus nerve runs downwards vertically between the two vessels, the ninth or glossopharyngeal sweeps forwards between the internal and external carotid arteries, the eleventh or accessory nerve curves backwards superficial to the internal jugular vein, and the twelfth or hypoglossal nerve swings forwards superficial to both the external and the internal carotid arteries. Note, further that the pharyngeal branch of the vagus lies between the two carotid arteries while its superior laryngeal branch passes deeply to both.

THE INTERNAL CAROTID ARTERY.

This artery commences opposite the upper border of the thyroid cartilage as the larger terminal branch of the common carotid artery, with which its course is a direct continuation. The artery leaves this dissection by entering the carotid canal in the petrous temporal bone, which conducts it into the skull.

Superficially the internal carotid is overlapped throughout its whole course except at its origin by the external carotid artery. The five structures that intervene between the two vessels have been already enumerated. From above downwards they are—

(1) the deep portion of the parotid gland,

(2) the styloid process,

(3) the stylo-pharyngeus muscle,

(4) the glossopharyngeal nerve,

(5) the pharyngeal branch of the vagus. The hypoglossal nerve also crosses it superficially, but is separated by the external carotid artery.

Posterior to the internal carotid artery are the transverse processes of the upper three or four cervical vertebrae, with the prevertebral muscles and fascia. The sympathetic cord runs downwards vertically behind the artery, and the superior laryngeal nerve passes forwards posterior to it. To the inner side of the internal carotid are the lateral wall of the pharynx and the ascending pharyngeal artery. In operations on the tonsil the relation of the internal carotid artery to the lateral pharyngeal wall should always be recollected.

At the base of the skull the internal jugular vein lies directly posterior to the internal carotid artery with the ninth, tenth, eleventh and twelfth cranial nerves intervening. Lower down, however, the vein comes to lie on the outer aspect of the artery, with the vagus or tenth cranial nerve alone intervening. Both vessels are invested with the carotid sheath.

The internal carotid artery gives off no branches in this part of its course.

THE INTERNAL JUGULAR VEIN.

This vein commences at the posterior compartment of the jugular foramen as the continuation of the lateral sinus of the skull. At the base of the skull it lies directly posterior to the internal carotid artery with the last four cranial nerves intervening. Lower down, however, the vein comes to lie on the outer sides of both the internal and common carotid arteries, with the vagus nerve intervening between them. At the root of the neck the internal jugular vein crosses in front of the first part of the subclavian artery and joins the subclavian vein to form the innominate vein at the inner border of the scalenus anterior. Throughout its course the internal jugular vein is enclosed in the carotid sheath.

The tributaries of the vein from above downwards are the inferior petrosal sinus, the pharyngeal veins, the common facial vein, the lingual veins, and the superior and middle thyroid veins. Moreover, at its junction with the subclavian vein it is joined on the left side by the thoracic duct and on the right side by the right lymphatic duct.

THE GLOSSO-PHARYNGEAL NERVE.

This is the ninth cranial nerve. It escapes from the skull through the middle compartment of the jugular foramen and possesses its own sheath of dura mater. At first it lies between the internal carotid artery and the internal jugular vein. It then sweeps forwards between the external and internal carotid arteries along the lower border of the stylo-pharyngeus muscle. On reaching the submaxillary region it passes under cover of the posterior border of the hyoglossus muscle and curves upwards to supply the mucous membrane of the posterior third of the tongue with sensory and gustatory fibres. Its trunk is joined by a small twig from the facial nerve which soon comes off again as the branch to the stylo-pharyngeus muscle. The glosso-pharyngeal, as its name implies, also gives a pharyngeal branch to supply the mucous membrane of the pharynx through the pharyngeal plexus of nerves. A small branch which pierces the superior constrictor muscle to supply the tonsil will also be found.

As the glosso-pharyngeal nerve lies in the jugular foramen two minute ganglia are developed upon it. The lower one of these gives off the tympanic nerve which enters a canal on the inferior aspect of the petrous temporal bone between the carotid canal and the jugular foramen. After supplying the mucous membrane of the middle ear this nerve is joined by a twig from the facial nerve, and then changes name into the small superficial petrosal nerve, which has been already shown to join the otic ganglion. These nerves will all be studied later.

THE VAGUS NERVE IN THE NECK.

This is the tenth cranial nerve. It emerges from the skull through the middle compartment of the jugular foramen, and possesses a sheath of dura mater in common with the accessory nerve. The vagus nerve runs vertically downwards in the neck, first of all between the internal carotid artery and the internal jugular vein, and finally between this vein and the common carotid artery, but on a more posterior plane. At the root of the neck it passes in front of the first part of the subclavian artery and enters the thorax, where its subsequent course has been already examined.

The vagus nerve possesses two ganglia—the root ganglion and the ganglion of the trunk. The root ganglion is situated in the jugular foramen and gives off the auricular nerve which supplies the external ear. Its course to this is rather circuitous, as it first of all enters a foramen on the floor of the jugular fossa of the petrous temporal bone, and emerges again from this bone through the auricular fissure which lies between the external auditory meatus and the mastoid process.

The ganglion of the trunk is a spindle shaped swelling nearly one inch long situated on the nerve just below the base of the skull. Note that immediately above this ganglion the vagus is joined by the medullary portion of the accessory nerve, and that the hypoglossal nerve is firmly bound to the trunk ganglion by an interchange of communicating filaments. The ganglion of the trunk gives off

the pharyngeal and the superior laryngeal branches of the vagus. Of these the pharyngeal branch proceeds forwards between the external and internal carotid arteries to join the pharyngeal plexus. Its fibres are accessory in origin, and represent the motor filaments for the supply of the pharyngeal muscles. The superior laryngeal branch is directed downwards and forwards on the deep aspects of both the internal and external carotid arteries. It divides into external and internal laryngeal branches of which the former supplies the crico-thyroid muscle, while the internal laryngeal nerve pierces the thyro-hyoid membrane in association with the superior laryngeal artery in order to supply the mucous membrane of the larynx with sensory filaments.

Further down the neck the vagus nerve will be found to give off the superior and inferior cardiac nerves which enter the thorax to join the cardiac plexuses. In addition, the right vagus nerve gives off the right recurrent laryngeal nerve at the root of the neck. This branch hooks round the first part of the right subclavian artery, and passes upwards and inwards behind the right common carotid artery to reach the groove between the trachea and the oesophagus. The left laryngeal nerve, as already shown, is given off in the thorax. Each nerve enters the larynx under cover of the lower border of the inferior constrictor muscle of the pharynx, and supplies the intrinsic laryngeal muscles of its own side except the crico-thyroid, which was already shown to be supplied by the superior laryngeal nerve.

THE ACCESSORY NERVE.

This is the eleventh cranial nerve. It consists of a medullary and a spinal portion which unite inside the skull. The nerve emerges through the middle compartment of the jugular foramen, possessing a sheath of dura mater common to it and the vagus nerve. It immediately divides into its accessory and spinal portions of which the former has been already shown to join the vagus. The spinal portion inclines downwards and backwards over the internal jugular vein to enter the deep surface of the sterno-mastoid muscle. After supplying this the nerve emerges from the posterior border of the muscle, crosses the posterior triangle of the neck and ends by supplying the trapezius.

THE HYPOGLOSSAL NERVE.

This is the twelfth cranial nerve. It escapes from the skull through the hypoglossal canal which tunnels the occipital condyle. The nerve appears in the deep dissection of the neck by winding around the ganglion of the trunk of the vagus to which it is attached by communicating filaments. It then sweeps forwards superficial to both the internal and external carotid arteries, and hooks round the origin of the occipital artery. The nerve passes under cover of the posterior belly of the digastric and the stylo-hyoid muscles, and enters the submaxillary region where it rests upon the superficial aspect of the hyoglossus muscle. It finally disappears from view by sinking into the genio-glossus muscle

and its terminal filaments supply the four intrinsic muscles of the tongue. It also innervates four extrinsic muscles namely, the genio-glossus, the hyoglossus, the stylo-glossus and the chondroglossus.

In addition to these cranial filaments of the hypoglossal nerve, there is an important branch of communication from the first cervical nerve which joins it below the base of the skull. This new set of fibres, which might be termed the spinal filaments of the hypoglossal nerve, come off again as the descendens hypoglossi, and the nerves to the thyro-hyoid and genio-hyoid muscles. The descendens hypoglossi is given off as the hypoglossal nerve hooks round the occiptal artery. This offshoot runs downwards in the carotid sheath in front of the common carotid artery to join the communicating branch from the second and third cervical nerves, the result being the nerve loop known as the ansa hypoglossi which supplies the sterno-hyoid, the sterno-thyroid and both bellies of the omo-hyoid.

THE CERVICAL SYMPATHETIC.

The cervical sympathetic cord is imbedded throughout its course in the posterior wall of the carotid sheath. It therefore lies behind the common and internal carotid arteries and in front of the prevertebral muscles and fascia. Above, it enters the skull through the carotid canal in the form of a plexus surrounding the internal carotid artery, while below it enters the thorax in front of the neck of the first rib and becomes continuous with the thoracic sympathetic. There are three ganglia on the cervical segment of the cord. The superior ganglion is an elongated spindle shaped structure about two inches long situated at the level of the second and third cervical vertebrae, therefore lying behind the internal carotid artery. It communicates with the first four cervical nerves by means of grey rami communicantes, and must therefore represent four ganglia fused together. The middle and inferior cervical ganglia are placed at the levels of the sixth and seventh cervical vertebrae behind the common carotid artery. Each represents two fused ganglia, since the middle communicates with the fifth and sixth cervical nerves and the inferior with the seventh and eighth by means of grey rami communicantes. The superior ganglion gives off the superior cardiac nerve, a branch to the pharyngeal plexus, an offshoot along the facial artery and communicating twigs to the ninth, tenth and twelfth cranial nerves. The middle ganglion furnishes the middle cardiac nerve and sympathetic nerves to the thyroid gland. The inferior ganglion gives off the inferior cardiac nerve and a large offshoot along the subclavian and axillary arteries. The two lower ganglia are often connected by a loop which passes in front of the first part of the subclavian artery.

The stylo-pharyngeus muscle will be observed to arise from the inner aspect of the root of the styloid process. It passes forwards between the external and internal carotid arteries to enter the wall of the pharynx, where it will be studied later. It is innervated by the glosso-pharyngeal nerve.

THE PREVERTEBRAL MUSCLES.

The longus colli is the name given to an irregular arrangement of scanty muscle slips connecting the bodies of the cervical and upper three dorsal vertebrae.

The rectus capitis anterior major takes origin from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebrae. The muscle passes upwards to the base of the skull where it is inserted into the under aspect of the basi-occipital. It is supplied by the first cervical nerve and its action is to tilt the head forwards.

The rectus capitis anterior minor lies behind the upper end of the major muscle. It takes origin from the atlas and obtains insertion into the basi-occipital behind the major muscle. Its nerve supply and action are the same as those of the preceding.

The rectus lateralis arises from the transverse process of the atlas and is inserted into the under aspect of the jugular process of the occipital bone. It is supplied by the first cervical nerve. Its action is to tilt the head to the same side.

DISSECTION.—The skull cap has now to be removed in order to extract the brain under the supervision of the demonstrator who will make the requisite mark on the bone with coloured chalk. In this operation the demonstrator will point out the various cranial nerves and processes of dura mater that must be severed in order to release the brain. Place this in a pot with a little spirit, for future study. The dura mater that constitutes the roof of the cavernous sinus on each side of the body of the sphenoid must be removed, and the various cranial nerves that are exposed will require to be identified.

THE CAVERNOUS SINUS.

This venous sinus is a space between the layers of the dura mater on the lateral aspect of the body of the sphenoid, and is so named on account of the numerous trabeculae that traverse its cavity. Anteriorly it ends at the sphenoidal fissure, where it receives the two ophthalmic veins, while its posterior extremity is in contact with the Gasserian ganglion on the apex of the petrous temporal bone, and is drained there by the superior and inferior petrosal sinuses. The inner wall of the sinus completes the fossa for the pituitary gland. The sloping outer wall has imbedded in it the following nerves—the third and fourth cranial nerves and the first and second divisions of the fifth cranial nerve. The lateral limit of the sinus is at the inner edge of the foramen ovale, a fact which excludes the third division of the fifth cranial nerve from the outer wall. This foramen, however, transmits an emissary vein from the sinus to join the internal maxillary vein. In the cavity of the sinus itself will be found the internal carotid artery, closely invested in its sympathetic plexus, to the outer side of which is the sixth cranial nerve. The structures are of course enclosed in a delicate membrane which separates them from the blood stream. Each cavernous sinus is connected with its fellow by means of the minute anterior and posterior intercavernous sinuses which lie behind and in front of the pituitary body.

THE DISSECTION OF THE ORBIT.

DISSECTION.—Most of the nerves that traverse the cavernous sinus are on their way to enter the orbit, the dissection of which is therefore a natural sequel. The roof of the orbit has to be removed under the supervision of the demonstrator. A little dissection with forceps will expose the fourth cranial nerve, the frontal and the lachrymal nerves, named from within outwards. Pick away the loose adipose tissue, and define the levator palpebrae superioris muscle as it rests upon the upper surface of the superior rectus muscle of the eyeball. Trace the lamellae of the levator muscle into the upper eyelid, and attempt to define the structure of the latter. Sever the frontal nerve and turn it forwards.

The levator palpebrae superioris arises from the roof of the orbit immediately in front of the optic foramen. The muscle expands anteriorly and divides into three lamellae of which the superior blends with the orbicularis oculi, the middle is attached to the tarsal plate of the upper eyelid and the lower is inserted into the superior fornix of the conjunctiva, which is the line of reflection of the conjunctiva from the eyelid on to the eyeball. The muscle is innervated by the third cranial nerve, and its action is to elevate the upper eyelid. Cut this muscle and turn it forwards.

THE OCULAR MUSCLES.

The superior rectus muscle of the eyeball takes origin from the upper margin of the optic foramen. Its insertion is into the sclerotic coat of the eyeball on its upper aspect about one quarter of an inch behind the corneo-sclerotic junction. Its nerve supply is from the third cranial or oculomotor nerve. Its action is to turn the eyeball upwards. Divide this muscle and turn it forwards in order to study the origins of the other three recti muscles.

The internal rectus arises from the inner margin of the optic foramen, and is directed forwards along the inner wall of the orbit to its insertion into the sclerotic on the inner aspect of the eyeball one quarter of an inch behind the corneo-sclerotic junction. It is supplied by the oculo-motor nerve. Its action is to turn the eyeball inwards.

The external rectus arises from the outer edge of the optic foramen and also from a special tubercle on the lower border of the sphenoidal fissure, thus dividing the latter into upper and lower compartments for the passage of its contents. The muscle is inserted into the outer aspect of the sclerotic about one quarter of an inch behind the corneo-sclerotic junction. It is supplied by the sixth cranial nerve, and its action is to turn the eyeball outwards.

The inferior rectus takes origin from the lower border of the optic foramen, and is inserted on the under aspect of the sclerotic about one quarter of an inch behind the corneo-sclerotic junction. It is supplied by the oculomotor nerve, and its action is to turn the eyeball downwards.

The superior oblique muscle takes origin above and to the inner side of the optic foramen. The muscle is directed forwards along the inner wall of the orbit. Its tendon passes through the pulley attached to the trochlear fossa

of the frontal bone, and then passes outwards and backwards under the superior rectus to obtain insertion into the outer aspect of the eyeball. It is innervated by the fourth cranial nerve. It acts along with the inferior rectus, and turns the eyeball downwards.

The inferior oblique muscle is best exposed by incising along the lower orbital margin and picking away the loose adipose tissue from under the eyeball. The muscle will be observed to arise from the orbital floor just external to the opening of the naso-lachrymal duct. It passes outwards underneath the inferior rectus to gain its insertion into the outer surface of the eyeball. It is supplied by the third cranial nerve. It acts along with the superior rectus, and turns the eyeball upwards.

THE NERVES OF THE ORBIT.

The second cranial or optic nerve arises from the optic commissure and enters the orbit through the optic foramen. It is directed forwards, outwards and slightly downwards, and pierces the eyeball just below and to the inner side of its posterior pole. It is distributed to the retina of the eye.

The third cranial or oculomotor nerve as it runs forwards in the outer wall of the cavernous sinus divides into upper and lower divisions which enter the orbit through the sphenoidal fissure below the external rectus muscle. The upper division supplies the superior rectus and the levator palpebrae superioris. The lower division innervates the internal rectus, the inferior rectus and the inferior oblique and also furnishes the motor root to the ciliary ganglion.

The fourth cranial or trochlear nerve enters the orbit through the sphenoidal fissure above the external rectus, and ends by supplying the superior oblique muscle.

The sixth cranial or abducens nerve enters the orbit through the sphenoidal fissure below the external rectus and ends in that muscle.

The first or ophthalmic division of the fifth cranial nerve takes origin from the Gasserian ganglion and is directed forwards in the outer wall of the cavernous sinus, where it divides into three branches. Of these the frontal and lachrymal enter the orbit through the sphenoidal fissure above the external rectus, while the nasal branch enters below that muscle.

The frontal nerve runs forwards immediately under the roof of the orbit and soon divides into its supra-orbital and supratrochlear branches which have been previously studied in the frontal region.

The lachrymal nerve is directed forwards along the outer wall of the orbit along with the lachrymal vessels and supplies secretory fibres to the lachrymal gland and minute twigs to the eyelids.

The nasal nerve passes forwards along the inner wall of the orbit just below the superior oblique muscle. It enters the anterior ethmoidal canal which conducts it on to the cribriform plate of the ethmoid. It leaves the cranium a second time by the side of the crista galli, and enters the nasal fossa, where it grooves the posterior surface of the nasal bone. It appears on the nose between

the lower border of the nasal bone and the lateral cartilage of the nose and ends in terminal sensory twigs to the nose. While in the nasal fossa it furnishes sensory twigs to both the septum and the outer wall. In the orbit it gives off an infratrochlear branch to the skin of the eyelids the two long ciliary nerves to the eyeball, and the sensory root to the ciliary ganglion. The latter lies near the apex of the orbit between the optic nerve and the external rectus muscle. It is rather quadrangular in form and its posterior border is joined by its sensory root from the fifth nerve, its motor root from the third nerve and its sympathetic root from the carotid plexus. The short ciliary nerves are its branches of distribution and proceed from its two anterior angles. These may be as many as twelve in number, and enter the eyeball in a ring round the entrance of the optic nerve. The motor filaments in the short ciliary nerves that are derived from the oculomotor nerve supply the sphincter pupillae and the ciliary muscle of accommodation, while the sympathetic filaments innervate the dilator pupillae.

THE OPHTHALMIC ARTERY.

This artery takes origin from the internal carotid and enters the orbit through the optic foramen below and to the outer side of the optic nerve. In the orbit it sweeps over the top of the optic nerve and takes its forward course from the inner wall. At the inner angle of the eye it ends by dividing into nasal and frontal branches of which the former anastomoses with the facial artery, and the frontal accompanies the supratrochlear nerve to supply the forehead. The other branches of the opthalmic are—

(1) the central artery of the retina,
(2) Supraorbital,
(3) lachrymal,
(4) anterior and posterior ethmoidal,
(5) long and short ciliary,
(6) internal palpebral,
(7) muscular branches to the orbital muscles.

The central artery of the retina sinks into the substance of the optic nerve and in this way enters the eyeball. It is distributed to the retina by upper and lower branches.

The supra-orbital artery accompanies the nerve of the same name through the supra-orbital notch or foramen to the forehead and scalp, where its distribution has been previously examined.

The lachrymal artery supplies the lachrymal gland, and likewise gives off external palpebral twigs to both eyelids.

The anterior and posterior ethmoidal arteries traverse the canals of the same name, and supply the anterior, middle and posterior groups of ethmoidal air cells. The anterior artery in addition furnishes a small anterior meningeal twig to the anterior cranial fossa.

The short ciliary arteries pierce the sclerotic round the entrance of the optic nerve, and supply the tissues of the eyeball. The two long ciliary arteries pierce

the sclerotic a little further forward in company with the two long ciliary nerves. A few anterior ciliary arteries which supply the front part of the eyeball spring from the other branches of the ophthalmic artery.

The internal palpebral arteries are minute twigs which run along the margins of the eyelids, and anastomose with the twigs from the lachrymal artery.

The two ophthalmic veins do not closely accompany the artery. In front they communicate with the facial vein. They receive tributaries corresponding to the branches of the artery, and pass through the bottom of the sphenoidal fissure in order to join the cavernous sinus.

THE LACHRYMAL APPARATUS.

This consists of

(1) the lachrymal gland and its ducts which open into the conjunctival sac,
(2) the two puncta, and the lachrymal canals,
(3) the lachrymal sac,
(4) The naso-lachrymal duct.

The lachrymal gland lies under the antero-external angle of the roof of the orbit. It is slightly constricted into two by the outer edge of the membranous expansion of the levator palpebrae superioris. The upper part lies in the lachrymal fossa of the frontal bone, and the lower portion rests against the upper eyelid. About twelve ducts emerge from the lower part of the gland, and open into the outer portion of the superior fornix of the conjunctiva. The eyeball is thus bathed with the glandular secretion from above downwards and inwards.

Each punctum is a minute pin point opening situated on the summit of a small papilla placed on the free margin of each eyelid just internal to the point where the eyelashes begin. The papilla is kept pressed against the eyeball in order to drain away surplus secretion by capillarity. The lachrymal canal into which the punctum opens tunnels the margin of the lid between it and the inner angle of the eye, and is thus less than a quarter of an inch long. These canals drain into the lachrymal sac. Note that the small red projection at the inner angle or canthus of the eye is termed the caruncle. Immediately external to this is a tiny vertical fold, known as the plica semilunaris which represents the third eyelid of some lower animals (the nictitating membrane of birds).

The lachrymal sac rests in the special fossa on the inner wall of the orbit formed by the superior maxilla and lachrymal bones, and is about half an inch long. Anteriorly it is crossed by the internal tarsal ligament as it passes to the eyelids, while posteriorly lies the tensor tarsi muscle. The latter arises from the lachrymal crest and blends externally with the palpebral fibres of the orbicularis oculi. Its evident function thus, is to compress the lachrymal sac against the resistant internal tarsal ligament, and express its contents.

The naso-lachrymal duct extends from the lower end of the lachrymal sac. It is half an inch long and is directed downwards, outwards and slightly backwards. Its opening in the fore end of the inferior meatus of the nose will be studied later.

THE CAPSULE OF TENON.

The eyeball is enclosed in a large lymph space, the idea being to keep it free from the surrounding orbital tissues and thus facilitate its movements. The wall of this lymph sac is known as Tenon's capsule and is so delicate that it is difficult to demonstrate. Posteriorly it blends with the sheath of the optic nerve, while anteriorly it blends with the sclero-corneal junction. The six tendons of the ocular muscles have to pierce it in order to reach their insertions and at these points the capsule blends with the tendon sheaths.

THE SUSPENSORY LIGAMENT OF THE EYEBALL.

This is represented by no definite band, but by an ill-defined aggregation of connective tissue which passes hammock-like underneath the eyeball from side to side. It is attached internally to the frontal process of the superior maxilla, and externally to the malar bone, half way up the orbital margin in each case. It is therefore important to remember not to disturb these attachments in excision of the superior maxilla, as otherwise proptosis of the eyeball would result.

THE EYELIDS.

Each eyelid presents the following layers from before backwards—

(1) the skin
(2) Superficial fascia
(3) Orbicularis oculi
(4) the tarsal plate
(5) the layer of Meibomian glands
(6) the conjunctiva

The skin will be observed to be very thin. The superficial fascia contains no fatty tissue and is very lax, so that extravasations of blood or fluid are very apt to take place in it. The palpebral portion of the orbicularis oculi muscle has been already shown to be attached internally and externally to the internal and external tarsal ligaments. The tarsal plate is a semilunar mass of condensed connective tissue which is attached externally and internally to the orbital margins by the external and internal tarsal ligaments, of which the latter is the better marked and is sometimes called the tendo oculi. The Meibomian glands open along the edge of the lid behind the lashes, the row of openings indicating the line of junction of the skin with the conjunctiva. The latter is the delicate layer covering the deep surface of the lid. It is reflected from this on to the eyeball, the line of reflection being termed the fornix of the conjunctiva.

DISSECTION.—The orbital contents will now require to be removed in order to investigate the second division of the fifth nerve. There is a peculiar aggregation of non-striated muscle towards the apex of the orbit, known as Muller's muscle. Exophthalmos is believed to be due to persistent contraction of these fibres. The infra-orbital groove will be found to contain part of the

second division of the fifth nerve. It will therefore be necessary to trace this forwards and backwards, and remove bone, where necessary. Lay open the sphenoid down to the level of the foramen rotundum, and also open up the spheno-maxillary fossa slightly from above.

THE SECOND OR SUPERIOR MAXILLARY DIVISION OF THE FIFTH CRANIAL NERVE.

This sensory nerve takes origin from the Gasserian ganglion, and runs forwards in the outer wall of the cavernous sinus to reach the foramen rotundum through which it leaves the cranium and enters the spheno-maxillary fossa. The nerve crosses the upper end of this narrow space, and enters the floor of the orbit, where it will be found lying in the infraorbital groove. It is continued forwards in the infra-orbital canal, and emerges on to the face through the infra-orbital foramen as the infra-orbital nerve, the distribution of which on the face has been already described. It is convenient to note that the chief branches of the second division of the fifth nerve are arranged in three groups, each composed of three nerves,—namely—three branches to the face, three branches to the upper teeth and three main branches of distribution from the spheno-palatine ganglion which is associated with this division of the fifth nerve.

The three sensory branches to the face are the infra-orbital, and the temporal and malar branches of the temporo-malar nerve. The distribution of these three nerves on the face has been previously examined. The temporo-malar nerve arises just as the main trunk enters the orbit, and is directed forwards in close contact with the outer orbital wall, where it divides into its temporal and malar branches. These enter their respective canals in the malar bone in order to reach their areas of supply.

The posterior superior dental nerve arises in the spheno-maxillary fossa and runs downwards on the posterior surface of the superior maxilla to reach the posterior superior dental canal which conducts it to the supply of the three upper molar teeth and the mucous membrane of the maxillary antrum.

The anterior and middle superior dental nerves arise in the infra-orbital canal which must be opened up to expose them. They run downwards in minute bony canals on the anterior wall of the maxillary antrum to reach the upper teeth. The anterior nerve supplies the two incisors and the canine, while the middle nerve is distributed to the two premolars. They also give twigs to the mucous membrane of the maxillary antrum.

The spheno-palatine ganglion is suspended from the nerve in the spheno-maxillary fossa by two rootlets, and it is joined posteriorly by the Vidian nerve. Its three chief branches are, the palatine stem, the nasopalatine nerve and the pharyngeal branch. The palatine stem divides into the great palatine and the two accessory palatine nerves, of which the former traverses the posterior palatine canal with the vessels of that name and is distributed to the mucous membrane of the hard and soft palates. The accessory palatine nerves traverse minute

vertical canals in the tuberosity of the palate bone, and supply the mucous membrane of the soft palate. The pharyngeal branch of the spheno-palatine ganglion traverses the pterygo-palatine canal with the vessels of that name, and supplies the mucous membrane of the pharyngeal roof and the Eustachian tube. The naso-palatine nerve enters the nasal fossa through the spheno-palatine foramen along with the vessels of that name. Its distribution to the mucous membrane of the nasal fossa will be examined later.

DISSECTION.—The head and neck must be detached and the base of the skull sawn transversely across at the middle of the basioccipital, under the supervision of the demonstrator. The organ of hearing in the temporal bone will be cut through, so that the parts will require to be preserved for future study. The anterior half of the section has attached to it the pharynx which will be examined next. Push some tow into the cavity from the mouth so as to distend its walls and facilitate their dissection.

THE PHARYNX.

The pharynx is a fibro-muscular tube four and a half inches long, lined with mucous membrane, which extends from the base of the skull downwards to the level of the sixth cervical vertebra, where it becomes continuous with the oesophagus. It exhibits seven apertures. Anteriorly it receives the openings of the two posterior nares, the mouth and the larynx. On each side wall close to the base of the skull is the opening of the Eustachian tube from the middle ear, while its lower end is continuous with the oesophagus. Its cavity is widest opposite the hyoid bone and narrows slightly towards each end. Its wall is composed of three layers. From without inwards these are—the three constrictor muscles with their fascial covering, the pharyngeal aponeurosis, and the mucous membrane.

The superior constrictor arises from the lower third of the posterior border of the internal pterygoid plate and its hamular process, from the pterygo-mandibular ligament, from the inner surface of the mandible and from the musculature of the tongue. The fibres sweep upwards and backwards round the lateral wall of the pharynx, and meet their fellows in the mesial raphe which extends downwards from the pharyngeal tubercle of the occipital bone, though a few of the uppermost fibres gain direct insertion into that bone. Its innervation is from the pharyngeal branch of the vagus through the pharyngeal plexus.

The middle constrictor takes origin from the great and lesser cornua of the hyoid and from the stylo-hyoid ligament. Its fibres spread out fanwise as they proceed backwards to their insertion into the pharyngeal raphe. Note that this muscle overlaps the superior muscle, and is in its turn overlapped by the inferior constrictor. Nerve supply as above.

The inferior constrictor arises from the lateral aspects of the thyroid and cricoid cartilages of the larynx. This muscle is also fanshaped, and its fibres are for the most part, inserted into the pharyngeal raphe, but the lowermost set sweeps downwards to become continuous with the longitudinal muscular coat of the oesophagus. Nerve supply as above.

It will be evident that there are manifest gaps between the constrictor muscles, and also between the superior muscle and the base of the skull. In each of these gaps two important structures will be found. Between the superior constrictor and the base of the skull a little dissection will expose the levator and tensor palati muscles, while, on separating these, a glimpse of the Eustachian tube will be obtained. Between the superior and middle constrictors the stylo-pharyngeus passes into the pharyngeal wall and at this point the glossopharyngeal nerve winds round it. In the gap between the middle and inferior constrictor muscles the internal laryngeal nerve and the superior laryngeal artery proceed forwards to pierce the thyro-hyoid membrane. Note that the recurrent laryngeal nerve and the inferior laryngeal artery pass upwards under cover of the lower border of the inferior constrictor muscle in order to reach the larynx.

The pharyngeal plexus is formed by the pharyngeal branches of the vagus and the glossopharyngeal nerves, and the superior cervical sympathetic ganglion. It is massed mainly on the surface of the middle constrictor muscle and through it the motor fibres from the vagus are distributed to the pharyngeal and palatal muscles, and the sensory fibres from the glossopharyngeal to the mucous membrane of the pharynx.

The pharyngeal aponeurosis is attached above to the base of the skull. It fills up the gaps between the constrictor muscles.

DISSECTION.—Open the pharynx from behind by a mesial incision and detach the walls freely from the base of the skull in order to expose the naso pharynx more fully. Wipe out the cavity and define its openings.

THE CAVITY OF THE PHARYNX.

It will be observed that the cavity of the pharynx is divided imperfectly into upper and lower chambers by the projecting soft palate.

The upper chamber is termed the naso-pharynx and presents four openings, viz.—the two posterior nares and the two Eustachian tubes. The former are vertically oval apertures, separated by the posterior edge of the vomer, which open directly backwards into the naso-pharynx from the nasal fossae. Each is one inch in height and half an inch in width. Immediately in front of the mid point of the outer border of each is seen the posterior end of the inferior turbinated process. Each Eustachian tube opens into the lateral wall of the naso-pharynx by a trumpet shaped opening, which is half an inch below the roof, half an inch from the posterior wall and half an inch behind the end of the inferior turbinate process. The rim of the opening is prominent above and behind but is deficient below, owing to a gap in the cartilage of the tube. The Eustachian tube is one and a half inches long and is directed backwards and outwards to communicate with the middle ear. The posterior one third is composed of bone while the anterior two thirds possess a wall of yellow elastic cartilage which is deficient below. The tube is completely lined by mucous membrane covered with ciliated epithelium. It is narrowest at the junction of the bone and cartilage, and is widest at its pharyngeal end. Behind the opening of the Eustachian tube is a

deep recess on the lateral wall of the naso-pharynx termed the retro-pharyngeal recess. The roof of the naso-pharynx is composed of mucous membrane covering the basi-occipital and basi-sphenoid. At the junction of the roof with the posterior wall is a mass of lymphoid tissue termed the pharyngeal tonsil which is the seat of adenoids. Note that the naso-pharynx is a portion of the respiratory tract and is therefore lined by ciliated epithelium.

The lower chamber of the pharynx is termed the oral pharynx, as the mouth opens directly backwards into it; and both, it may be noted, are lined by stratified squamous epithelium. The other two openings into this chamber are those of the larynx and oesophagus. The opening from the mouth is termed the fauces, which is bounded above by the soft palate with the uvula, below by the posterior one third of the tongue, and on each side by the anterior and posterior pillars of the fauces with the tonsil lying in the recess between them. A little dissection will show that the anterior pillar contains a small muscle bundle termed the palato-glossus, while the posterior contains the palato-pharyngeus which joins the stylo-pharyngeus in order to gain insertion into the posterior border of the thyroid cartilage. The two pillars of the fauces converge above as they join the soft palate, so that the tonsil occupies the lower portion of the gap between them the unoccupied portion above the tonsil being termed the supratonsillar fossa.

The opening into the larynx is triangular in outline. The base is above and in front, and is formed by the posterior surface of the epiglottis. Each lateral margin is represented by the aryteno-epiglottidean fold of mucous membrane in which two tiny swellings produced by minute cartilages of the larynx may be distinguished. The apex of the aperture is much lower than the base and is formed by the inter-arytenoid fold. Note the presence of a deep recess, termed the pyriform fossa, on each side of the laryngeal aperture.

The lower end of the pharynx narrows rapidly, and it becomes continuous with the oesophagus opposite the sixth cervical vertebra.

DISSECTION.—Trace the levator and tensor palati muscles downwards and the palato-glossus and palato-pharyngeus upwards into the palate and endeavour to ascertain their dispositions there. This is a matter of difficulty, and requires much skill and manipulation.

THE SOFT PALATE.

The soft palate is a fibro-muscular curtain attached to the posterior edge of the hard palate, and covered on its upper and under surfaces with mucous membrane. The characteristic mesial projection from its posterior border is termed the uvula. The uppermost strata of the palatal musculature are formed by a splitting of the palato-pharyngeus into two layers which enclose between them the levator palati and azygos uvulae muscles. The palato-glossus forms the lowermost stratum and between it and the palato-pharyngeus lies the tendinous expansion of the tensor palati. All these muscles are supplied by the pharyngeal branches of the vagus except the tensor which is innervated by the otic ganglion.

The levator palati arises from the under aspect of the apex of the petrous temporal bone and from the inner aspect of the cartilage of the Eustachian tube. It is inserted into the palatal aponeurosis.

The tensor palati lies in front and to the outer side of the preceding. It arises from the navicular fossa at the root of the internal pterygoid plate and from the outer aspect of the cartilage of the Eustachian tube. The tendon hooks round the hamular process, and is inserted partly into the palatal aponeurosis and partly into the horizontal plate of the palate bone.

The azygos uvulae takes origin from the posterior nasal spine on the posterior edge of the hard palate. It is a tiny twin bundle of muscle fibres which extends backwards into the uvula.

The two lamellae of the palato-pharyngeus meet their fellows in a mesial decussation in the soft palate. Each muscle is directed downwards in the posterior pillar of the fauces and is joined by a small bundle from the cartilage of the Eustachian tube, known as the salpingo-pharyngeus. The union of the palato-pharyngeus with the stylo-pharyngeus has been already noted.

The palato-glossus meets its fellow on the under aspect of the palate in a mesial decussation. The muscle proceeds downwards in the anterior pillar of the fauces, and blends with the stratum transversum of the tongue.

The palatal aponeurosis is the common meeting place of the palatal muscles, and is attached to the posterior border of the hard palate.

The mucous membrane of the palate is supplied by the great and the accessory palatine nerves and by the ascending and descending palatine arteries. Note that it is rather rich in lymphoid tissue.

DISSECTION.—Make a sagittal section of the anterior portion of the basis cranii just to one side so as to preserve the nasal septum. It is difficult to avoid damaging the turbinated processes. Saw down into the mouth and turn the halves aside so as to study the nasal fossae.

THE NASAL FOSSAE.

The nasal fossae are narrow chambers placed on each side of the nasal septum Each is two inches in height. The width is half an inch at the floor but is reduced to a mere cleft at the roof. Each nasal fossa possesses a roof, a floor, inner and outer walls, anterior and posterior apertures.

The roof consists of a middle horizontal portion represented by the cribriform plate of the ethmoid, a posterior sloping portion consisting of the anterior and inferior aspects of the body of the sphenoid and an anterior sloping portion provided by the under surface of the nasal bone. The floor is concave from side to side and is formed by the mucous membrane covering the upper surface of the hard palate. The posterior apertures of the nasal fossae or posterior nares look directly backwards into the naso-pharynx and have been already examined. The anterior apertures or nostrils look directly downwards, and inside each is the vestibule of the nasal fossa. formed by both the inner and outer walls.

The inner wall of the nasal fossa is represented by the nasal septum. The upper one third or so of this is formed by the vertical plate of the ethmoid, the portion below and behind this being completed by the vomer, and the portion below and in front by the septal cartilage. There are two very distinct areas of mucous membrane on the nasal septum. Thus the portion covering the vertical plate of the ethmoid is the olfactory mucous membrane, and contains the ramifications of the olfactory nerves as they supply the olfactory epithelium. The remainder of the mucous membrane of the septum is respiratory, and is therefore lined by ciliated epithelium. The nasal nerve gives a few twigs to the fore part of this, but the chief nerve is the naso-palatine which will be found running downwards and forwards underneath the mucous membrane covering the vomer. This nerve is a branch of the second division of the fifth nerve and enters the nasal fossa through the spheno-palatine foramen. At first, therefore, it passes inwards on the roof, and then runs downwards in a faint groove in the vomer. It supplies the respiratory mucous membrane of the septum, and then passes through one of the mesially placed foramina in the anterior palatine canal in order to end in the mucous membrane of the hard palate. The nasopalatine is the artery of the septum and accompanies the nerve, but it passes through one of the laterally situated foramina in the anterior palatine canal. Note that the depressed area of the septum just inside the nostril corresponds to the position of the vestibule. It is lined by integument, and exhibits a series of short hairs arranged so as to exclude dust from the nasal fossa.

The outer wall of the nasal fossa presents the superior, middle and inferior turbinate processes, which represent the three turbinate bones covered with a thick and highly vascular mucous membrane. The superior process exists only in the posterior half of the outer wall, and is therefore quite short, but may be double. The middle process is at first directed downwards and backwards in front of the superior process and then runs almost horizontally backwards below it. The inferior process is the longest and is practically horizontal in position throughout its extent. Below each turbinate process is the corresponding meatus of the nose. The superior middle and inferior meatuses are thus passages on the outer wall of the nasal fossa, each of which is overhung by the corresponding turbinate process. In the superior meatus will be found the opening of the posterior ethmoidal air cells. On levering up the middle turbinate process an obliquely placed groove termed the hiatus semilunaris will be exposed. This is curved round a slight bulging of the wall termed the ethmoidal bulla. At the posterior end of this hiatus is the opening of the maxillary antrum, while the anterior end turns upwards, and is continuous with a passage termed the infundibulum, which leads upwards into the frontal sinus. The anterior ethmoidal air cells will also be found to open into the anterior part of the hiatus semilunaris. The opening of the middle ethmoidal air cells is situated between the bulla and the middle turbinated process. There is only one opening into the inferior meatus, namely that of the naso-lachrymal duct, which opens near its anterior end. Look next for the opening of the sphenoidal air sinus which is into the spheno-ethmoidal recess between the superior turbinate process and the roof of the nasal

fossa. The depressed area of the outer wall inside the nostril corresponds to the nasal vestibule, and like that on the septum, is lined by integument and covered by short hairs (vibrissae). The area on the outer wall between the vestibule and the anterior ends of the turbinate processes is termed the atrium.

The olfactory area of the outer wall consists of the mucous membrane covering the superior turbinate process, the anterior end of the middle turbinate process and the portion of the outer wall between these and the roof. It is lined by olfactory epithelium. The remainder of the mucous membrane of the outer wall, like that of the respiratory area of the septum, is covered by ciliated epithelium, and is innervated by twigs from the fifth cranial nerve. These are furnished by the nasal, anterior superior dental, and the palatine nerves, and the spheno-palatine ganglion and are excessively minute. The spheno-palatine is the artery of the nasal fossa. It is one of the terminal branches of the internal maxillary artery, and enters the nasal fossa through the spheno-palatine foramen. It furnishes the naso-palatine artery to the septum, and is itself distributed to the outer wall.

Note that the anterior portion of the outer wall of the nasal fossa, like that of the septum, is completed by cartilage. This is termed the lateral cartilage of the nose and is attached to the nasal notch of the superior maxilla. It is united to the septal cartilage by the cartilage of the aperture, which completes each nostril anteriorly and also forms the tip of the nose.

DISSECTION.—Very little dissection will be required to detach the larynx with the tongue, trachea and oesophagus from the remainder. Cut away the extrinsic muscles and the inferior constrictor from the laryngeal cartilages, and strip off the pharyngeal mucous membrane posteriorly.

THE LARYNX.

This is a portion of the respiratory tract specially modified for the production of voice. It consists of a skeletal framework composed of nine cartilages which are connected together by certain membranes and joints. The latter are acted upon by certain muscles as part of the vocal mechanism. The interior is lined by mucous membrane, and presents the important vocal cords.

There are three single and three paired cartilages. The epiglottis, thyroid and cricoid cartilages represent the former. The paired cartilages are the two arytenoids, the two cuneiform cartilages and the two corniculae.

The outline of the epiglottis can be recognized under the mucous membrane. It is a leaf shaped piece of yellow elastic cartilage. The stalk is directed downwards and is attached to the angle between the alae of the thyroid cartilage by a tiny ligament. Its posterior surface is entirely covered by mucous membrane and bounds the laryngeal aperture anteriorly. It presents a slight projection of the mucous membrane termed the cushion of the epiglottis. The anterior surface is covered only in its upper part by mucous membrane and is attached to the root of the tongue by the three glosso-epiglottidean folds. The lower part of

the anterior surface is attached to the musculature of the tongue. Each lateral margin is attached to the arytenoid cartilage by the aryteno-epiglottidean muscles and folds of mucous membrane.

The thyroid cartilage consists of two quadrangular plates or alae connected together by their anterior borders to form the angle of the thyroid. The upper end of this union forms the characteristic projection in the middle line of the neck, popularly known as Adam's apple. The upper border of the ala forms a concavo-convex curve from behind forwards, and affords attachment to the thryo-hyoid membrane which will be observed to pass upwards to the body and great cornu of the hyoid bone, and to be pierced by the internal laryngeal nerve and the superior laryngeal artery. In the middle line it is attached to the upper border of the body of the hyoid and is separated from the posterior surface of the bone by a bursa. Note that the crico-thyroid membrane is attached to the lower end of the angle of the thyroid cartilage, while its upper border is free and forms the fibrous basis of the true vocal cord. The posterior border of the ala gives insertion to the stylo-pharyngeus, and exhibits projections at its upper and lower ends termed the superior and inferior cornua. The superior cornu affords attachment to the posterior border of the thyro-hyoid membrane, while into the angle formed by the inferior cornu and the lower border of the ala is inserted the crico-thyroid muscle. The inner surface of the inferior cornu presents a tiny flat facet for articulation with the cricoid cartilage. The outer surface of the ala exhibits an oblique line which affords attachment to the sterno-thyroid and thyro-hyoid muscles. The area below and behind this is occupied by the thyroid origin of the inferior constrictor of the pharynx. The inner surface of the thyroid ala forms the lateral boundary of the pyriform fossa of the pharynx.

DISSECTION.—Sever one ala of the thyroid cartilage from its attachment to the angle and remove it. A little dissection will expose the arytenoid cartilage and its muscles.

The cricoid cartilage is shaped like a signet ring, the broad portion being at the back. It therefore presents inferior and superior borders, and external and internal surfaces. The inferior border is horizontal and is attached to the uppermost ring of the trachea by a strong membrane. The superior border is horizontal posteriorly and then suddenly slopes downward and forwards at a point which is occupied by an oval facet for the base of the arytenoid cartilage. The sloping portion of this border gives attachment to the crico-thyroid membrane which extends upwards and ends in a free upper border composed of yellow elastic fibres. This passes from the angle between the alae of the thyroid to the vocal process of the arytenoid and forms the fibrous basis of the true vocal cord. On the lateral aspect of the outer surface of the cricoid cartilage is a small round facet which forms a gliding joint with the inferior cornu of the thyroid. In front of this facet is the origin of the crico-thyroid muscle, above and in front is the origin of the lateral crico-arytenoid muscle, immediately below is the origin of the inferior constrictor, and behind is a very definite quadrangular area for the origin of the posterior crico-arytenoid muscle. The internal surface of the cricoid cartilage is closely lined by the mucous membrane of the larynx.

Each arytenoid cartilage is shaped like a three sided pyramid. It therefore presents a base, an apex and internal, posterior and antero-external surfaces. It is slightly bent backwards upon itself. The base exhibits an oval facet which articulates with the facet on the cricoid, the joint being enclosed in a fibrous capsule. The arytenoids possess a gliding motion towards or away from one another at these joints, as well as a rotatory movement round their long axes. To the apex of each arytenoid is attached the cornicula, which is a tiny nodule of yellow elastic cartilage. The cuneiform cartilage is a similar nodule which lies in front of each cornicula in the aryteno-epiglottidean fold.

The posterior surface of the arytenoid is slightly concave from above downwards, and affords attachment to the transverse and oblique fibres of the unpaired arytenoideus muscle. The oblique fibres are prolonged beyond the arytenoids into the aryteno-epiglottidean fold as the aryteno-epiglottidean muscle which is inserted into each lateral margin of the epiglottis. The internal surface of the arytenoid looks towards its fellow. They are both covered by an extension backwards of the mucous membrane of the larynx, and thus form the posterior one third of the glottis.

The antero-external surface gives attachment to the thyro-arytenoid muscle which is attached anteriorly to the angle between the thyroid alae, and lies on the lateral aspect of the vocal cord. A few of the fibres of this muscle may be observed to sweep upwards and join the aryteno-epiglottidean muscle.

The anterior angle of the base of the arytenoid gives attachment to the true vocal cord and is therefore termed the vocal process. The cord has been already shown to be the free upper border of the crico-thyroid membrane, and to be composed of yellow elastic fibres. It is attached in front to the angle between the thyroid alae a little below its middle. The external angle of the base of the arytenoid cartilage is sometimes called the muscular process, as it receives anteriorly the insertion of the lateral crico-arytenoid and posteriorly the insertion of the posterior crico-arytenoid.

It is now evident that the functions of the laryngeal muscles are—

(1) To widen the glottis which is the cleft between the true vocal cords,

(2) To reduce the width of the glottis,

(3) To tighten the vocal cords,

(4) To slacken the vocal cords,

(5) To constrict the upper aperture of the larynx during deglutition.

The posterior crico-arytenoid muscles widen the glottis by pulling the muscular processes of the arytenoids backwards. The lateral crico-arytenoid muscles close the glottis by pulling the muscular processes of the arytenoids forwards. Their actions are supplemented by that of the arytenoideus muscle which pulls the arytenoids towards one another. The crico-thyroid muscles tighten the true vocal cords by pulling the thyroid cartilage forwards, and therefore away from the arytenoids. On the other hand the thyro-arytenoid muscles slacken the cords by pulling the thyroid and the arytenoids towards one another. Finally,

the upper aperture of the larynx is constricted during deglutition by the arytenoepiglottidean muscles. Note that all these muscles are innervated by the recurrent laryngeal nerves except the crico-thyroids which are supplied by the external laryngeal nerves.

DISSECTION.—Make a mesial sagittal section of the posterior wall of the larynx and turn the flaps aside in order to examine the interior.

THE CAVITY OF THE LARYNX.

Each lateral wall of the laryngeal cavity presents upper and lower folds. The latter are the true vocal cords, and are closer together than the upper folds or false vocal cords. The cleft between the true vocal cords is termed the glottis, which also extends backwards between the inner surfaces of the arytenoid cartilages. It will thus be noted that the vocal cords constitute the anterior two thirds of the complete glottis. The average length of the latter in the male is 23 mm. and 16 or 17 mm. in the female. Between the true and the false cord on each side wall is a recess termed the laryngeal sinus, which is a resonating chamber. The presence of the true and false cords has been utilised to divide the laryngeal cavity into upper, middle and lower compartments. When examined from above, both sets of cords are seen, owing to the false cords being further apart, as well as higher up, than the true cords. The lower compartment rapidly widens out into the trachea. The interior of the larynx is lined by ciliated epithelium except over the true cords, where this is replaced by stratified squamous epithelium which is directly attached to the cords owing to the absence of submucous tissue. The mucous membrane of the larynx is supplied by the internal laryngeal nerve.

THE THYROID GLAND.

This ductless gland consists of two lateral lobes connected together in front of the trachea by the isthmus. The latter is situated in front of the second, third and fourth tracheal rings, and each lateral lobe is moulded against the sides of the trachea and larynx. It may be noted that each lateral lobe is rather pear shaped, and that the isthmus connects together the lower or broad ends, the apical portion of each being moulded against the sides of the larynx. The fibrous capsule of the gland is firmly adherent to the pretracheal layer of the deep cervical fascia. Anteriorly the gland is also covered by the sterno-hyoid and sterno-thyroid muscles and by the deep fascia, the platysma, superficial fascia and skin. On each side the lateral lobe comes into close association with the common carotid artery which may create a groove on the gland. The pyramidal lobe is occasionally present. It is attached to the upper border of the isthmus, and is in its turn connected to the hyoid bone by a band of nonstriated muscle. The latter represents part of the wall of the obliterated thyro-glossal duct which in the embryo had its opening at the site of the foramen caecum of the tongue.

The distribution of the superior and inferior thyroid arteries to the gland has been already examined. An extra vessel termed the lowest thyroid artery may be present. This springs from the innominate, and runs upwards in front of the trachea between the inferior thyroid veins which are really its venae This explains why superior, middle and inferior sets of thyroid veins are present. The nerve supply of the thyroid gland is from the middle cervical sympathetic ganglion.

The parathyroids are minute flattened bodies found in relation to the thyroid gland. They are numbered III and IV to signify that they are developed from the third and fourth pharyngeal pouches of the embryo. Parathyroid III is usually found adherent to the lower pole of the lateral lobe of the thyroid while parathyroid IV may be discovered a little higher up on the posterior aspect of the same.

THE TRACHEA IN THE NECK.

The trachea is four and a half inches long, and is situated partly in the neck and partly in the thorax, about one half being in each region. It begins at the lower border of the cricoid cartilage opposite the sixth cervical vertebra as a continuation of the larynx. Its anterior relations in the neck are—the isthmus of the thyroid gland which lies in front of the second and third and fourth rings, the inferior thyroid veins and perhaps the lowest thyroid artery. As it enters the thorax the left innominate vein crosses obliquely in front of it. More superficial are the pre-tracheal fascia, the sterno-hyoid and sterno-thyroid muscles, the deep fascia, the superficial fascia and the skin. Note that as the trachea descends it gets deeper and deeper from the surface. Posteriorly is the oesophagus, with the recurrent laryngeal nerve lying in the groove between the two tubes. On each side are the lateral lobe of the thyroid gland and the common carotid artery.

The trachea consists of a series of horse shoe shaped rings of hyaline cartilage, imbedded in a dense fibrous membrane. The ends of the rings are directed backwards, and are connected together by bundles of nonstriated muscle, constituting the trachealis muscle. The mucous membrane is lined by ciliated epithelium. In cross section the trachea has a D-shaped outline.

THE OESOPHAGUS IN THE NECK

The oesophagus is ten inches long but has a very brief course in the neck It begins opposite the sixth cervical vertebra as a continuation of the pharynx It is directed downwards and slightly to the left in the neck. In front is the trachea with the recurrent laryngeal nerve lying in the groove between the two tubes on each side. Posteriorly are the sixth and seventh cervical vertebrae with the longus colli muscles. Laterally is the common carotid artery.

THE TONGUE.

In studying the mucous membrane of the tongue it is best to locate first of all the position of the foramen caecum, which will be recognised as a slight depression in the middle line of the dorsum at the junction of the anterior two thirds with the posterior one third. Leading forwards and outwards on each side from this is a groove termed the sulcus terminalis which maps off the dorsum of the tongue into posterior one third and anterior two thirds, the mucous membrane of which displays totally different characters. The mucous membrane of the posterior one third is non-papillated and therefore comparatively smooth. It is dotted over, however, with the crypts of the lingual tonsils which are readily recognised. The anterior two thirds of the dorsum of the tongue are covered with papillae which are grouped into three categories. Arranged in a V shaped manner directly in front of the sulcus terminalis are the circumvallate papillae, which are recognised by the fact that each is mapped out by a ring. One of these is directly in front of the foramen caecum, and there are usually four or five others placed on each side of it. The fungiform papillae are dotted irregularly over the dorsum and are especially numerous at the tip and sides. The pointed or filiform papillae are of course by far the most numerous and are closely packed all over the anterior two thirds of the dorsum.

There are certain folds of mucous membrane to be noted in association with the tongue. Its root is attached to the anterior aspect of the epiglottis by the middle and the two lateral glosso-epiglottidean folds, which bound the two glosso-epiglottidean fossae. The connection with the anterior pillar of the fauces on each side has been previously noted. Examine next the fraenum which connects the under aspect of the tongue to the floor of the mouth. On each side of the under surface is a slight fringed fold, hence termed the plica fimbriata. Finally, on each lateral margin, about two thirds of the way back is a series of vertical ridges, supposed to represent the papilla foliata of the rabbit. Note that the mucous membrane of the anterior two thirds of the tongue is supplied by the lingual nerve, and that of the posterior one third by the glosso-pharyngeal nerve. This is only approximate.

The intrinsic musculature of the tongue is best studied in a transverse section. There are four extrinsic and four intrinsic muscles of the tongue. The extrinsic muscles have been previously studied. These are the genio-glossus, the stylo-glossus, the hyo-glossus and the chondroglossus. The four intrinsic muscles are the stratum transversum, the verticalis, the lingualis superior and the lingualis inferior. The fibres of the stratum transversum and the verticalis interlace at right angles to one another. The lingualis superior runs longitudinally from the tip to the root of the tongue underneath the mucous membrane of the dorsum and is broken up into bundles by the fibres of the verticalis. The lingualis inferior is represented by a longitudinal bundle of muscle on the under surface of the tongue, on each side of the genio-glossus muscles as they enter the organ to mingle with the fibres of the verticalis. All the intrinsic and extrinsic muscles of the tongue are innervated by the hypoglossal nerve.

THE LYMPHATICS OF THE HEAD AND NECK.

The lymph from the anterior quadrant of the scalp is drained into the auricular glands in front of the ear, while that from the posterior quadrant passes to a group of small glands situated below and behind the ear. The lymph from the face is drained into the submaxillary group of glands and their efferents enter the deep cervical glands. The latter form an extensive chain of glands situated along the course of the internal jugular vein. They receive the lymph drainage from the nasal fossae, the mouth, pharynx, larynx, trachea, thyroid gland and oesophagus. The lymph from the tongue and mouth goes partly to them and partly to the submaxillary glands. The efferents from the deep cervical glands enter the thoracic duct on the left side and the right lymphatic duct on the right side.

The supra-clavicular lymph glands in the base of the posterior triangle of the neck receive the lymph drainage from the upper limb. A set of glands higher up in the posterior triangle, along the posterior border of the sterno-mastoid is of importance as a diagnostic feature in secondary syphilis.

THE ORGAN OF HEARING.

The organ of hearing is divided into three parts—the external ear, the middle ear, and the internal ear.

The external ear consists of the auricle and the external auditory meatus.

The auricle is composed of a framework of yellow elastic cartilage continuous with the cartilaginous portion of the external auditory meatus, and covered with skin and subcutaneous tissue. The prominent inturned margin is termed the helix, which presents posteriorly Darwin's tubercle, a structure of evolutionary importance. Anteriorly it ends at the crus of the helix immediately above a prominent nodule termed the tragus, which overhangs, and therefore guards the opening into the external auditory meatus. Inside the helix is another ridge termed the antihelix which will be observed to end above in two crura. Inside this again, is a deep depression known as the concha which leads into the external auditory meatus. The soft dependent portion at the lower end of the auricle is termed the lobule.

The external auditory meatus is fully one inch long, and is directed forwards and inwards. It is closed at its inner end by the drum or tympanic membrane of the ear. The inner two thirds of the meatus are composed of bone and the outer one third of yellow elastic cartilage which is firmly attached to the rough outer edge of the tympanic plate. Note that the meatus is slightly curved upon itself and that it is narrowest in its middle segment. Its roof is slightly shorter than its floor owing to the obliquity of the tympanic membrane. The meatus is lined by integument which also covers the outer surface of the drum. Its outer segment is studded with ceruminous or wax secreting glands, and exhibits a series of fine hairs designed to exclude dust.

THE MIDDLE EAR.

The middle ear or tympanum is a cavity in the petrous temporal bone. This is best exposed by a sagittal section of the bone through its site, each half of the section thus exhibiting the outer and inner walls. Try to preserve the three ossicles of the middle ear during this operation. As a further help it is useful to have a macerated temporal bone, sectioned in a similar manner, alongside one during the study of the middle ear. The cavity will be observed to possess inner, outer, anterior and posterior walls, a roof and a floor. It measures half an inch in height and half an inch from before backwards. The distance between the outer and inner walls is reduced to one sixth of an inch owing to the fact that each of these bulges into the cavity.

The inner wall of the middle ear presents at its centre a bulging termed the promontory. This is produced by the first turn of the cochlea, and exhibits a minute branching groove for the tympanic branch of the glossopharyngeal nerve which supplies the mucous membrane of the middle ear. Above and behind the promontory is the fenestra ovalis, into which fits the foot-piece of the stapes, surrounded by its annular ligament. Below and behind the promontory is the fenestra rotunda, occupied by a membrane which closes the lower end of the scala tympani of the cochlea. Above and in front of the promontory is a small shelf of bone which is prolonged forwards into the anterior wall, and divides it into two canals. The tensor tympani muscle rests upon this shelf and then hooks outwards round its posterior end to reach the tympanic membrane. At the junctions of the inner wall with the roof and the posterior wall is a right angled projection representing a portion of the aqueduct for the facial nerve. Attached to this at a point directly behind the fenestra ovalis is a minute hollow projection termed the pyramid from which the stapedius muscle emerges in order to gain insertion into the stapes, one of the auditory ossicles.

The outer wall of the middle ear is represented by the tympanic membrane or drum which is fitted into a special bony rim. The latter, however, exhibits a notch or deficiency above, and the portion of membrane filling this gap has been termed the membrana flaccida. Note the obliquity of the drum, the result of which is that its inner surface looks also upwards. The drum is composed of an outer integumentary layer, an intermediate fibrous layer consisting of concentric and radiating fibrils and an internal layer of mucous membrane. Imbedded in the fibrous layer in its upper half is the handle of the malleus which is directed downwards and slightly backwards, its lower end terminating at the centre of the membrane. The chorda tympani nerve may be found passing forwards over the upper end of the handle of the malleus, and just below this is the insertion of the tensor tympani muscle into it. The traction of this muscle keeps the membrana pulled inwards towards the cavity of the tympanum and produces the characteristic "cone of light" on the outer surface of the drum when examined with the otoscope. Leading upwards from the outer wall towards the roof of the tympanum is a recess, termed the attic, for the reception of the head of the malleus and the body of the incus (anvil). Note finally that the petro-tympanic fissure

is situated at the junction of the outer wall with the anterior wall of the tympanum and transmits the chorda tympani nerve and the tympanic artery.

The anterior wall exhibits upper and lower canals of which the upper transmits the tensor tympani muscle into the cavity, while the lower is the osseous portion of the Eustachian tube which communicates with the pharynx.

The posterior wall exhibits, high up, the opening into the mastoid antrum. Note that the inner wall of this opening is formed by the facial aqueduct, from which the chorda tympani nerve emerges at this point. The mastoid antrum is a small cavity in the mastoid temporal, lined by an extension of the mucous membrane of the middle ear, and in its turn communicates with the mastoid air cells.

The roof of the middle ear is formed by a thin lamina of bone termed the tegmen tympani which separates it from the middle cranial fossa.

The floor of the tympanum is bevelled off in front by the carotid canal for the internal carotid artery, and behind by the jugular fossa for the internal jugular vein, two very important relationships.

The three ossicles of the ear, the malleus, the incus and stapes, form a chain connecting the membrana tympani with the fenestra ovalis.

The malleus or hammer consists of a head, a handle and a short process. The head is situated in the attic. It is rounded in outline and presents a facet on its posterior aspect for articulation with the incus. The handle has been already studied with the tympanic membrane. The short process is attached at the junction of the handle with the head and abuts against the upper end of the tympanic membrane.

The incus or anvil consists of a body, a short process and a long process. The body presents a hollow facet for the reception of the head of the malleus, a small diarthrodial joint connecting the two. The short process is attached to the roof of the tympanum by a ligament. The long process is directed downwards parallel to the handle of the malleus, lying postero-internal to it. On its lower end is a minute knob which looks inwards for articulation with the stapes.

The stapes or stirrup is so named from its characteristic shape. The foot piece is attached to the fenestra ovalis by its annular ligament. Its anterior end is pointed and is called the toe. The two limbs or crura of the stapes are curved, the posterior crus more so than the anterior. The cup shaped head receives the end of the long process of the incus in a minute diarthrodial joint. The neck of the stapes affords insertion posteriorly to the stapedius muscle.

The tympanum is lined by mucous membrane which is continuous posteriorly with that lining the mastoid antrum and air cells, and anteriorly with that of the naso-pharynx through the Eustachian tube. It is also reflected over the auditory ossicles, and covers the inner surface of the drum.

THE INTERNAL EAR OR LABYRINTH.

The internal ear consists of an intricate cavity in the petrous temporal bone termed the bony labyrinth, filled with perilymph in which floats the delicate membranous labyrinth.

The osseous labyrinth presents a central cavity termed the vestibule, which is only one quarter of an inch in diameter. Its outer wall exhibits the fenestra ovalis, occupied by the foot piece of the stapes. On the inner wall are numerous minute foramina for the transmission of the branches of the auditory nerve, and also the aqueduct of the vestibule which contains a blind tube from the membranous labyrinth. On the posterior wall of the vestibule are the openings of the three semicircular canals, while anteriorly is the opening into the cochlea. The latter is a canal coiled upon itself two and a half times round a central pillar (the modiolus), and therefore looks like a snail shell.

The membranous labyrinth consists in the first place of two minute sacs termed the utricle and the saccule floating in the perilymph of the vestibule. These are connected together by a Y shaped tube, the blind end of which fits unto the aqueduct of the vestibule as previously stated. The utricle is the larger and is posterior in position. It therefore gives attachment posteriorly to the three semicircular canals. The latter are named superior, posterior and external. The two former are joined together at one end to form a right angle which looks directly outwards towards the lateral aspect of the body, while the external canal lies horizontally between them. It is therefore clear that they constitute the three dimensions of space, and are associated with the balancing of the body.

The saccule is connected with the scala media of the cochlea by means of a short canal. The scala media contains the end organ of hearing (the organ of Corti) and passes upwards in the spiral cochlear canal which it divides into two other scalae—the scala vestibuli and scala tympani. Thus a sound wave is transmitted by the foot piece of the stapes to the perilymph of the vestibule, and is continued from there up the scala vestibuli, round the blind end of the scala media and down the scala tympani to impinge against the membrane of the fenestra rotunda. The vibrations of the perilymph in these scalae affect the endolymph of the scala media, and hence the organ of Corti.

The auditory nerve divides in the internal auditory meatus into cochlear and vestibular divisions, of which the cochlear supplies the organ of hearing, while the vestibular portion innervates the organ of equilibration.

THE INTRA-PETROUS PORTION OF THE FACIAL NERVE.

At the bottom of the internal auditory meatus the facial nerve is joined by the pars intermedia and enters the facial aqueduct. It is at first directed outwards and forwards for a short distance. It then turns backwards suddenly at the site of the geniculate ganglion, and lies along the junction of the inner wall with the roof of the tympanum. Finally it makes a right angled bend and is directed vertically downwards behind the tympanum to its exit at the stylomastoid foramen. The geniculate ganglion gives off the great superficial petrosal nerve. The latter emerges through an opening on the upper surface of the petrous temporal bone, and is joined by a branch from the carotid plexus to form the Vidian nerve, which traverses the canal of the same name to join the sphenopalatine ganglion. The geniculate ganglion also furnishes a small twig which

joins the tympanic branch of the glosso-pharyngeal to form the small superficial petrosal nerve. The latter emerges from the upper surface of the petrous temporal bone just external to the great superficial petrosal, and turns downwards between the petrous temporal and the great wing of the sphenoid to join the otic ganglion. The descending portion of the facial nerve gives off the nerve to the stapedius and the chorda tympani which, as already shown, crosses the upper part of the tympanic membrane and the handle of the malleus in order to reach the petro-tympanic fissure through which it leaves the skull to join the lingual nerve.

THE EYEBALL.

The eyeball in dissecting room subjects is usually in a state of collapse so that it is necessary to supplement the dissection by studying the eyeball of the ox.

In order to gain a true appreciation of the mechanism of the eyeball, it is useful to compare it to a photographic camera. In this case the wall of the camera is represented by the sclerotic, which is lined inside by the black pigment of the choroid and iris, just as a photographic camera has to be painted black inside to prevent reflection of light from its walls. In the eye the focussing mechanism is represented by the muscles of accommodation, while the refractive media take the place of the photographic lens. The iris provides the moveable diaphragm, while the sensitive retina takes the place of the photographic plate, and transforms the light impressions that fall upon it into nerve impulses which stimulate the visual centres of the brain.

The eyeball possesses an outer protective coat or sclerotic, an intermediate vascular and pigmented coat termed the choroid, and finally the retina.

The sclerotic is composed of tough interlacing fibrous tissue, and forms about five sixths of the area of the eyeball. The remaining sixth is completed by the transparent cornea which forms a segment of a smaller sphere, and thus bulges slightly in advance of the sclerotic. At the corneosclerotic junction the sclerotic overlaps the cornea, particularly above and below. The sclerotic is pierced by the fibres of the optic nerve below and to the inner side of the posterior pole of the eyeball.

The choroid presents three strata in which pigment is irregularly distributed. The outer stratum contains the ciliary arteries and nerves as they course forwards to the ciliary region. The middle stratum is occupied by a mass of veins remarkably arranged in four vortices, and hence named the venae vorticosae. The inner stratum of the choroid is represented by a layer of capillaries. When traced forwards the choroid gets broken up just behind the corneo-sclerotic junction into a series of ridges termed the ciliary processes which contain the ciliary muscles of accommodation. In front of the ciliary processes the choroid is projected inwards towards the cavity of the eyeball as the pigmented iris, which exhibits an opening—the pupil of the eye. The iris contains the sphincter pupillae which surrounds the pupil, and the dilator pupillae composed of radiating fibres. The nerve supply to these has been already shown to be from the third cranial nerve and the sympathetic respectively.

The retina possesses an outer pigmented layer and an inner layer which exhibits nine strata under the microscope. The retina is prolonged forwards to cover the ciliary processes and the back of the iris. In this position both retinal layers are pigmented and form the uvea. The serrated edge between the pigmented and non-pigmented portions of the inner layer of the retina displays a characteristic appearance, and is termed the ora serrata.

The greater part of the cavity of the eyeball behind the iris is occupied by the vitreous which is a clear transparent jelly-like substance. This is enclosed in the hyaloid membrane which is firmly attached to the ciliary portion of the retina, and is there termed the zonule. Immediately in front of this point the zonule splits into two lamellae, the posterior one of which sweeps behind the lens to complete the bag for the vitreous, while the anterior lamella passes to the equator of the lens, and there splits again into two layers which fuse with the capsule of the lens, thus constituting the suspensory ligament of the lens.

The lens in health is clear and crystalline. It is highly elastic and is always tending to bulge forwards, but is held in shape by its capsule and suspensory ligament. At rest the posterior surface of the lens is more convex than the anterior. In accommodating the eye for near objects the radiating fibres of the ciliary muscle, which arise from the corneo-sclerotic junction, contract and pull upon the zonule, the result of which is to relax the suspensory ligament of the lens. The latter immediately bulges forwards by its elasticity.

The anterior chamber of the eye is the space between the cornea and the front of the iris, while the posterior chamber is the narrow cleft between the back of the iris and the front of the lens. They communicate with one another through the pupil, and are both filled with aqueous humor.

In this description of the eye, only those structures which can be seen with the eye, or by means of a pocket lens, have been referred to. For further microscopic detail the student is recommended to study textbooks of histology.

THE BRAIN.

The three membranes of the brain, named from without inwards, are the dura mater, the arachnoid mater and the pia mater.

The dura mater is a strong fibrous membrane which constitutes the internal periosteal layer for the cranial bones, and at the same time sends inwards septa between the main portions of the brain. It is therefore described as consisting of an outer periosteal layer, and an inner supporting layer which separates from the other at certain points. The various venous sinuses of the skull are situated between the two layers of the dura mater along these lines of separation. The existence of two dural layers is well demonstrated at the foramen magnum, where the periosteal layer sweeps round the margin of this opening to become continuous

with the periosteum outside the skull, while the inner supporting layer is prolonged downwards into the spinal canal as the dura mater of the spinal cord.

The four septa of the dura mater are—

(1) The falx cerebri,

(2) The tentorium cerebelli,

(3) The falx cerebelli,

(4) The diaphragma sellae.

The falx cerebri, as its name implies, is a sickle shaped process of dura mater, which is attached by its narrow anterior end to the tip and posterior border of the crista galli of the ethmoid. Its convex upper border is attached to the mid line of the cranial vault, and is occupied by the superior longitudinal sinus. The latter begins anteriorly as an emissary vein which communicates with the veins of the nasal fossae through the variable foramen caecum, while posteriorly it ends at the internal occipital protuberance by diverging to the right or left (usually the right) and becoming continuous with the lateral sinus. The lower free edge of the falx cerebri projects downwards between the cerebral hemispheres, and touches the posterior end of the corpus callosum. This margin contains the minute inferior longitudinal sinus which ends posteriorly by joining the great vein of the brain to form the straight sinus. The posterior end of the falx cerebri is much wider than the anterior and is attached to the upper surface of the tentorium cerebelli. Along this line of union the straight sinus runs backwards towards the internal occipital protuberance, and diverges usually to the left to become continuous with the left lateral sinus.

The tentorium cerebelli forms a tent-like roof over the posterior cranial fossa and the hind brain, the door of the tent being occupied by the mid-brain. On each side the tentorium is attached along the line of the lateral sinus and more anteriorly along the upper border of the petrous temporal along which the superior petrosal sinus courses backwards to join the lateral sinus. The anterior end of the attached border of the tentorium terminates at the posterior clinoid process, while the tentorial free border sweeps forwards over this to obtain attachment to the anterior clinoid process on each side.

Each lateral sinus sweeps outwards along the attached border of the tentorium and grooves the occipital bone and the posterior inferior angle of the parietal. It then dips downwards in the groove on the mastoid temporal bone to reach the posterior compartment of the jugular foramen, where it leaves the skull and becomes continuous with the internal jugular vein.

The falx cerebelli is attached to the internal occipital crest and therefore fits in between the lobes of the cerebellum. The occipital sinus runs upwards along its attached border, and ends in the right or left lateral sinus.

The diaphragma sellae is attached to the four clinoid processes, and therefore forms a roof for the pituitary fossa. The opening in its centre is for the stalk of the pituitary gland. Between its layers are the minute anterior and posterior inter-cavernous sinuses which connect the two cavernous sinuses. The latter have been previously described

THE ARACHNOID MATER.

When the brain is removed from the cranium, both the arachnoid and the pia come out with it, owing to the fact that the arachnoid is united to the pia mater by innumerable fibrous processes, while the pia is intimately attached to the brain substance.

The arachnoid is a thin semi-transparent non-vascular membrane which is distinguished from the pia by the fact that it bridges across the cerebral fissures while the pia mater dips down to the bottom of each. It will be observed that the cerebral arteries and veins lie between the arachnoid and pia. This fact is very apparent at the base of the brain, where all the large arteries lie in an extensive space between the arachnoid and the pia termed the cisterna basalis, so called because normally it is full of cerebro-spinal fluid. Another of these cisternae may be observed between the under aspect of the cerebellum and the dorsal aspect of the medulla.

THE PIA MATER.

This is the vascular membrane of the brain. All the smaller blood vessels ramify in it and send their branches deeply into the cerebral substance. The pia mater therefore covers every portion of the brain intimately and dips to the bottom of all the fissures. It also sends an extensive fold termed the velum interpositum into the interior of the brain. This will be studied later.

DISSECTION.—Remove the arachnoid along the courses of the numerous arteries that ramify on the surface of the brain, and study the main distribution of these.

THE ARTERIAL SUPPLY OF THE BRAIN.

The vertebral arteries enter the skull through the foramen magnum. They gradually converge in front of the medulla, and unite at the lower border of the pons to form the basilar artery. Each gives off.

(1) A posterior meningeal artery,
(2) The posterior spinal artery,
(3) The anterior spinal artery,
(4) The posterior inferior cerebellar artery, and
(5) Twigs to the medulla.

The posterior meningeal artery supplies the dura mater in the posterior cranial fossa.

The posterior spinal artery divides into two branches which run downwards on the lateral aspect of the spinal cord to supply it. On the other hand the two anterior spinal arteries unite to form a single vessel which runs downwards on the anterior aspect of the cord and dispenses twigs to it.

The posterior inferior cerebellar artery supplies the posterior part of the under surface of the cerebellum.

The basilar artery begins, as already explained, at the lower border of the pons, and runs upwards in the basilar groove to its termination at the upper border where it divides into the right and left posterior cerebral arteries. Its other branches are—

(1) The anterior inferior cerebellar,

(2) Pontine to the pons,

(3) Internal auditory,

(4) The superior cerebellar.

The anterior inferior cerebellar artery supplies the anterior portion of the under surface of the cerebellum, while the superior cerebellar, which arises close to the termination of the basilar, supplies the upper surface of the cerebellum.

The internal auditory artery enters the internal auditory meatus to supply the internal ear.

The internal carotid artery after entering the cranium through the carotid canal, traverses the cavernous sinus and on emerging from this gives off the ophthalmic artery and twigs to the pituitary gland. It then divides into the anterior and middle cerebral arteries, after having sent a posterior communicating branch to the posterior cerebral artery. A short stem which connects the two anterior cerebral arteries is known as the anterior communicating artery. In this way an arterial circle is produced known as the circle of Willis, which is composed from before backwards as follows—the anterior communicating, the two anterior cerebral, the two internal carotid, the two posterior communicating and the two posterior cerebral arteries.

The middle cerebral artery should now be traced outwards in the lateral fissure of the brain and its distribution on the outer surface of the hemisphere examined. Its branches stream out from both lips of the lateral fissure, and supply the greater portion of the outer surface of the hemisphere, leaving margins little more than one inch wide next to the upper and lower borders which are supplied by the anterior and posterior cerebral arteries respectively. Posteriorly its area of supply extends as far as a line continuing the parieto-occipital fissure downwards, thus leaving the outer surface of the occipital lobe to be supplied by the posterior cerebral artery.

DISSECTION.—The demonstrator should now release one hemisphere by severing the corpus callosum and the crus cerebri, in order to be able to examine its mesial surface.

On the mesial aspect of the hemisphere the anterior cerebral artery will be observed to sweep upwards round the anterior end of the corpus callosum. It supplies the mesial surface as far back as the internal parieto occipital fissure, thus leaving the posterior cerebral to supply the mesial aspects of the occipital and temporal lobes of the hemisphere.

The central or basal arteries of the brain pass through the three perforated spaces to supply the basal ganglia. Each middle cerebral artery gives off one group which enters the anterior perforated space. The latter is found at the very commencement of each lateral fissure on the base of the brain, and is recognised

by the little cluster of arteries piercing it. One of these vessels is the lenticulo-striate which usually ruptures in apoplexy. The posterior perforated space is found at the bifurcation of the basilar artery and therefore receives its basal arteries from both posterior cerebral arteries.

The cerebral veins are arranged in three main groups. Those of the superior group enter the superior longitudinal sinus from behind forwards and inwards and are therefore directed against its current. The inferior group enters the lateral, petrosal and cavernous sinuses. The third group is represented by the great vein of the brain which drains its interior, and emerges from under cover of the posterior extremity of the corpus callosum. Its termination in the straight sinus has been previously studied.

THE LOBES, CONVOLUTIONS AND FISSURES.

The outer surface of each hemisphere is covered by a layer of grey matter enclosing a core of white matter and is divided into frontal, parietal, occipital and temporal lobes by three fissures—the lateral fissure (Silvius), the central fissure (Rolando) and the parieto-occipital fissure.

The lateral fissure begins on the base of the brain at the anterior perforated space, and curves outwards in front of the temporal pole to reach the outer surface of the hemisphere, when it immediately divides into anterior, ascending and posterior limbs. The anterior limb is short and turns forwards almost horizontally into the frontal lobe. The ascending limb is directed upwards into the frontal lobe, while the posterior inclines backwards and slightly upwards between the frontal and temporal lobes, and ends in an upturned tail in the parietal lobe. On separating the edges of the fissure well it will be recognised that its production is due to the meeting of four lips over a submerged area of the cortex cerebri termed the island. The latter is a triangular area of cortex in which five small convolutions may be counted.

The central fissure commences on the upper edge of the hemisphere half an inch behind the mid point between its frontal and occipital poles, and is directed downwards and forwards on its outer surface for about three and a half inches, to end immediately above the middle of the posterior limb of the lateral fissure. Its course is slightly sinuous, its upper half being concave forwards and the lower half convex forwards.

The parieto-occipital fissure is less than an inch long, as seen on the outer surface of the hemisphere. It is situated about two inches in front of the occipital pole. If it be continued downwards by an imaginary line towards the lower margin of the hemisphere and the lateral fissure be similarly continued backwards, four lobes will be mapped out. The frontal lobe is bounded above by the upper border of the hemisphere, below by the lateral fissure, behind by the central fissure, and in front by the frontal pole of the brain. The parietal lobe is bounded above by the upper margin of the hemisphere, below by the line of the lateral fissure in front by the central fissure and behind by the line of the parieto-occipital fissure. The occipital lobe is bounded in front by the line of the parieto-occipital

fissure and behind by the occipital pole of the hemisphere. The temporal lobe is limited above by the lateral fissure, below by the lower margin of the hemisphere, behind by the continuation of the parieto-occipital fissure and in front by the temporal pole.

FISSURES AND CONVOLUTIONS ON THE OUTER SURFACE OF THE HEMISPHERE.

The fissures of the brain make an amazingly complex figure, so that the most important of these need only be mentioned. In the frontal lobe the upper and lower portions of the precentral fissure will be readily found, as they lie immediately in front of the central fissure. The ascending frontal convolution, is mapped off by these fissures and is one of the most important in the brain for it contains the motor areas. The upper end controls the movements of the leg of the opposite side. Below this is the area for the trunk muscles of the opposite side. Still further down is the motor area for the opposite upper limb, while at the lower end is the motor area for the opposite side of the head and neck. A further examination of the frontal lobe will demonstrate the existence of upper and lower horizontally directed fissures which usually join the upper and lower portions of the precentral fissure, thus producing two T's placed on their sides. These are the superior and inferior frontal fissures, which map off the superior, middle and inferior frontal convolutions. The inferior frontal convolution is cut into by the anterior and ascending limbs of the lateral fissure, thus dividing it into three portions—the pars orbitalis, the pars triangularis and the pars basilaris, named from before backwards. It may be noted that the pars basilaris is immediately in front of the motor area for the head and neck, and is said to contain the motor centre for speech.

The parietal lobe presents the ascending parietal or post-central fissure, which is directly posterior to the central fissure and more or less parallel to it. Between the two lies the ascending parietal convolution. There is only one horizontal fissure in the parietal lobe. It is joined to the post central fissure by its anterior end. Between it and the upper margin of the hemisphere is the superior parietal convolution, which is continuous round the end of the parieto-occipital fissure with the superior occipital convolution. The lower portion of the parietal lobe is cut into by the tails of three fissures—the lateral, the superior temporal and the inferior temporal fissures from before backwards. Curving around the end of each of these is an arching convolution or gyrus. The most important of these is the angular gyrus, which is bent round the tail of the superior temporal (parallel) fissure, and contains the word seeing centre for the interpretation of written and printed speech.

The occipital lobe is comparatively small. It presents two ill defined fissures which might be termed the superior and inferior occipital fissures, thus mapping off superior, middle and inferior occipital areas or convolutions.

The temporal lobe likewise exhibits only two fissures, the superior temporal or parallel, and the inferior temporal. Their tails extend upwards into the

parietal lobe, as previously stated. The inferior fissure is often broken up into two or more component parts. There are therefore three temporal convolutions—superior, middle and inferior. The superior and middle are the most important as they contain the centre for hearing.

FISSURES AND CONVOLUTIONS ON THE MESIAL SURFACE OF THE HEMISPHERE.

The convolutions on the mesial surface of the hemisphere are arranged in an outer and an inner circle round the corpus callosum.

The inner circle is conveniently termed the rhinencephalon as it contains the centre for the perception of smell. The portion of it that arches above the corpus callosum is termed the callosal convolution, which is mapped off below by the callosal fissure and above by the extensive calloso-marginal fissure. The portion of the rhinencephalon that curves forwards below the corpus callosum is named the hippocampal convolution, from its fancied resemblance to a sea horse. The recurved portion at its anterior end is termed the uncus, and represents the head of the sea horse. Note that the calcarine fissure cuts into the rhinencephalon from behind and thus maps off the callosal from the hippo-campal convolution, the narrow neck connecting the two being termed the isthmus.

The olfactory bulb and peduncle will require to be examined at this stage. They will be found lying in the olfactory sulcus on the orbital surface of the frontal lobe close to the mesial border of the hemisphere. When traced backwards the peduncle divides into two roots which enclose between them the anterior perforated space. One root passes to the anterior extremity of the callosal convolution and the other to the uncus.

The fissure which maps off the hippocampal convolution externally is termed the collateral fissure, while the one on its mesial aspect is the dentate fissure, so called because it contains the dentate convolution, which is the atrophied remains of a portion of the rhinencephalon. Note further, that the uncus is mapped off from the temporal pole of the hemisphere by a slight fissure termed the incisura temporalis.

The outer circle of lobes and convolutions on the mesial surface of the hemisphere is composed of the following, named from before backwards—

(1) The marginal convolution is quite extensive and is situated between the upper border of the hemisphere and the prominent callosomarginal fissure. The upturned posterior end of the latter terminates on the upper border of the hemisphere immediately behind the upper end of the central fissure.

(2) The term quadrate lobe is applied to the quadrangular area between the tail of the calloso-marginal fissure, the upper border of the hemisphere, and the parieto-occipital fissure. The latter will be observed to run downwards and forwards on the mesial surface of the hemisphere to its junction with the calcarine fissure. The latter is a prominent fissure which begins on the occipital pole and runs almost horizontally forwards. Its anterior end has been already shown to cut deeply into the rhinencephalon.

(3) The cuneate lobe is the wedge shaped area between the converging parieto-occipital and calcarine fissures.

(4) The narrow convolution between the calcarine fissure and the posterior end of the collateral fissure is termed the lingula. It is important to note that the visual cortex (the striate cortex) is represented by the grey matter immediately surrounding the posterior part of the calcarine fissure. It therefore includes portions of the cuneate lobe and of the lingula.

(5) The inferior occipito-temporal convolution, as its name implies, is the term applied to the elongated convolution on the under surfaces of the occipital and temporal lobes, lying immediately external to the collateral fissure.

Three of the fissures in this neighbourhood create certain elevations on the walls of the ventricular cavity of the hemisphere, and are on that account classed as complete fissures. They are the dentate fissure, the collateral fissure and the anterior end of the calcarine fissure.

On the orbital surface of the frontal lobe the olfactory sulcus has been already studied, as it was found to lodge the olfactory bulb and peduncle. External to it is an H shaped sulcus which maps off the anterior, posterior, external and internal orbital convolutions.

THE CORPUS CALLOSUM.

This is the great commissure connecting together the right and left hemispheres It is described as consisting of a body with a rounded posterior end or splenium, and a curved anterior end or genu, terminating below in a rostrum. The upper surface presents on each side a minute bundle of white fibres, the longitudinal striae, which pass from the anterior perforated space to the dentate convolution Laterally the upper aspect of the body passes into the callosal sulcus, in which a slender band of white fibres termed the cingulum will be found. Note once more that the lower edge of the falx cerebri which lies in the mesial fissure between the hemispheres, touches the posterior part of the upper surface of the corpus callosum.

The under surface of the corpus callosum is in contact in the mid line with the septum lucidum in its anterior half and the body of the fornix in its posterior half. More laterally the fibres of the corpus callosum pass into each hemisphere, and form the roof of the lateral ventricle. Note that the fibres from the genu and splenium sweep forwards and backwards respectively towards the frontal and occipital poles.

DISSECTION.—Slice away the upper part of one hemisphere down to the level of the corpus callosum, and then remove the body of the latter carefully in order to expose the cavity of the lateral ventricle.

THE LATERAL VENTRICLES.

Each hemisphere presents a cavity termed the lateral ventricle. These communicate with the mesially situated third ventricle by means of the inter-

ventricular foramen. The third ventricle is connected by means of the aqueduct of the mid brain with the fourth ventricle, which in its turn is continuous with the central canal of the spinal cord. These cavities are full of cerebro-spinal fluid which escapes into the subarachnoid space through openings in the roof of the fourth ventricle. The lining membrane of the ventricular system is termed the ependyma.

Each lateral ventricle consists of a body from which anterior, posterior and descending horns project.

The body possesses a roof formed by the fibres of the corpus callosum, and a floor which presents the following five structures from before backwards—

(1) The body of the caudate nucleus which becomes rapidly attenuated in a backward and outward direction to form an elongated tail which enters the roof of the descending horn.

(2) The taenia semicircularis which is a minute bundle of nerve fibres lying in an obliquely placed groove between the projections caused by the caudate nucleus externally and the optic thalamus internally.

(3) A small portion of the optic thalamus, resting upon which are the fourth and fifth structures.

(4) The choroid plexus of blood vessels which forms the fringed lateral border of the velum interpositum.

(5) The lateral margin of the body of the fornix.

The anterior horn of the lateral ventricle is directed forwards, outwards and slightly downwards. It is separated from its fellow of the opposite side by the septum lucidum which forms its inner wall. Above is the body of the corpus callosum, in front is the genu of the corpus callosum, and in the floor will be found the rostrum and the head of the caudate nucleus.

The posterior horn curves horizontally backwards and inwards. On its inner wall are upper and lower elevations. The lower is produced by the anterior end of the calcarine fissure and is termed the hippocampus minor, while the upper projection is produced by the splenial fibres of the corpus callosum as they sweep backwards towards the occipital pole.

The descending horn is much the longest. It is directed at first outwards and backwards, and then curves gently downwards, forwards and inwards. It contains an extension of the choroid plexus of the lateral ventricle. In the roof the tail of the caudate nucleus and the taenia semicircularis pass forwards to end in the amygdaloid nucleus. In the floor is an elongated projection termed the hippocampus major, produced by the dentate fissure. This ends anteriorly in a trilobed structure known as the pes hippocampi. The posterior pillar of the fornix will be observed to extend into the descending horn. It fuses partially with the surface of the hippocampus major, but extends beyond this, and ends in the uncus. To the outer side of the hippocampus major is a faint projection of the floor of the descending horn produced by the collateral fissure, and hence called the collateral eminence.

THE THIRD VENTRICLE.

This ventricle is situated in the mid line, and has therefore been opened in the removal of one hemisphere. It is a very narrow cleft situated between the two optic thalami, and presents lateral walls, a roof, a floor, an anterior wall and a posterior wall.

In each lateral wall is the optic thalamus which may bulge so much into the cavity, that its ependymal covering fuses with that of its fellow. Immediately in front of the anterior pole of the optic thalamus is the interventricular foramen leading into the lateral ventricle, the anterior boundary of this being formed by the anterior pillar of the fornix.

The roof is formed from above downwards by the corpus callosum, the body of the fornix and the velum interpositum. The latter is a fold of pia mater tucked into the interior of the brain under cover of the fornix and corpus callosum. It is triangular in shape like the body of the fornix, only it is a little wider, so that its margin which contains the choroid plexus projects into the cavity of the lateral ventricle, as previously described. From its under surface a slight choroid plexus of blood vessels projects into the third ventricle. Between its layers are two veins which unite to form the great vein of the brain. The latter, as already shown, enters the straight sinus.

In the floor of the third ventricle are the following structures from before backwards—

(1) The infundibulum, which is a funnel shaped depression leading to the stalk of the pituitary body. The latter lies in its fossa in the base of the skull and therefore becomes detached when the brain is removed. Note that the stalk is connected with the posterior portion of the gland. The anterior portion is developed from the roof of the primitive mouth, and is also structurally different from the posterior.

(2) The corpora mammillaria are two small bodies shaped like mammae, placed side by side. They are cell stations in the fornix system, as will be shown presently.

(3) The posterior perforated space which transmits the basal arteries to the basal ganglia.

At the junction of the floor with the anterior wall is attached the optic commissure, which is connected with the rostrum of the corpus callosum by a thin lamina of grey matter termed the lamina cinerea.

The anterior wall of the third ventricle is closed in by the two anterior pillars of the fornix as they sweep downwards side by side towards the corpora mammillaria. In a mesial section of the brain the minute anterior commissure will be observed immediately in front of these as it sweeps across between the hemispheres.

The posterior wall is very much shorter than the anterior. It presents the opening of the aqueduct which leads to the fourth ventricle. Immediately above this is the minute posterior commissure, and above this again is the pineal gland, a small cone shaped structure which is the atrophied remains of a third eye.

The fornix consists of a body with two anterior and two posterior pillars. The body is triangular in shape with an anterior and two lateral angles. It is partially fused to the posterior half of the under surface of the corpus callosum and is interposed between the latter and the velum interpositum. The two anterior pillars spring from its anterior angle and run downwards side by side in the anterior wall of the third ventricle, immediately in front of the right and left interventricular foramina. They end in the corpora mammillaria from which fresh relays of fibres forming the mammillo-thalamic bundles proceed to the two optic thalami. Each posterior pillar takes origin from the lateral angle of the fornix. It sweeps downwards and outwards into the descending horn of the lateral ventricle and ends in the uncus. The fornix is thus a commissure associated with the rhinencephalon.

The septum lucidum is a thin lamina occupying the angular gap between the under aspect of the corpus callosum and the anterior pillars of the fornix. It therefore lies between the anterior horns of the lateral ventricles. It contains a tiny cleft in its interior misnamed the fifth ventricle.

DISSECTION.—A few thin horizontal slices with the knife below the level of the floor of the lateral ventricle will expose the basal ganglia.

THE BASAL GANGLIA.

The basal ganglia are masses of grey matter imbedded in the white matter towards the base of the brain. They are—the optic thalamus, the caudate nucleus, the lenticular nucleus and the claustrum. In the horizontal section just prepared the optic thalamus will be first recognised as it lies in the lateral wall of the third ventricle. Immediately in front of it is the head of the caudate nucleus, while lying external to both these ganglia is the lenticular nucleus, so called from its shape. Between the latter and the cortex of the island is a thin streak of grey matter termed the claustrum. The white matter on the outer and inner aspects of the lenticular nucleus has been termed the external and internal capsule respectively. That portion of the internal capsule between the lenticular nucleus and the optic thalamus is by far the most important, as its anterior two thirds contain the motor fibres descending from the motor areas while the posterior one third contains the sensory, the visual and the auditory fibres. In the motor portion the fibres to the opposite half of the body are arranged as follows from before backwards—head and neck, upper limb, trunk and lower limb.

DISSECTION.—Release the other hemisphere by severing it above the crus, in order to study the mesencephalon or mid brain. This will be studied from its dorsal and ventral aspects first of all and then sectioned transversely across.

THE MID BRAIN.

In cross section the mid brain will be seen to be tunnelled near its dorsal aspect by the aqueduct, connecting the third and fourth ventricles. An imaginary plane at this level is utilised to divide the mid brain into dorsal and ventral portions.

The dorsal portion of the mid brain consists of the four corpora quadrigemina, two superior and two inferior, of which the former are the larger. Each corpus will be observed to give off laterally a small arm or brachium. On tracing these outwards two other projections on the lateral aspect of the mid brain will be observed. These are the external and internal genicular bodies which are intimately associated with the optic tract. The latter will be observed to be formed by offshoots from the posterior end of the optic thalamus and the external and internal genicular bodies, and it is also joined by the superior brachium. The inferior brachium passes under cover of the internal genicular body, but apparently does not become continuous with the optic tract. Each optic tract sweeps forwards round the lateral aspect of the mid brain to meet its fellow in the optic commissure from which the optic nerve takes origin as already described. The decussation of the fibres in the commissure is so arranged that the right halves of both retinae are supplied from the right hemisphere, and vice versa.

The ventral portion of the mid brain is composed of the two crura cerebri, each of which when studied in section, will be observed to be divided by a narrow crescentic strip of pigmented grey matter, termed the substantia nigra, into anterior and posterior portions. The anterior portion contains in its middle three fifths the motor tracts in their course downwards from the internal capsule. The posterior portion of each crus cerebri, sometimes termed the tegmentum, contains the sensory tracts which are aggregated to form the mesial and lateral fillets. The two crura cerebri are separated ventrally by a deep cleft through which appears on each side the third or oculomotor nerve. The latter takes origin from the grey matter lining the aqueduct and in its passage forwards through the crus cerebri traverses a mass of grey matter situated on each side of the mid line termed the red nucleus. The posterior longitudinal bundle which lies in contact with the grey matter lining the aqueduct can only be studied satisfactorily with the microscope; but it is important to note here that it connects together the nuclei of origin of the third, fourth and sixth cranial nerves, and thus coordinates the innervation of the ocular muscles. The fourth nerve also arises from the grey matter lining the aqueduct; but it pierces the roof of the fourth ventricle. It may be seen, however, at this stage as it proceeds forwards round the outer aspect of the crus cerebri.

THE HIND BRAIN.

The hind brain consists of the pons, medulla and cerebellum. It is situated in the posterior cranial fossa and is roofed in by the tentorium cerebelli.

The pons is so named from the superficial stratum of transverse fibres which connects together the right and left lobes of the cerebellum, and forms the middle peduncle of the latter. The pons is one inch in extent from the upper to the lower border. The upper border receives the two crura cerebri, while the lower is continuous with the medulla. The ventral surface of the pons rests upon the dorsum sellae of the sphenoid. It presents mesially the basilar groove for the basilar artery, the ridge on each side of which is created by the motor fibres as they run

downwards from the crura cerebri to the medulla in the deeper strata of the pons. The dorsal surface of the pons forms the upper half of the floor of the fourth ventricle, and will therefore have to be studied later. On each side the transverse fibres of the pons converge slightly, and become continuous with the middle peduncle of the cerebellum, the point of junction being indicated by the exit of the fifth cranial nerve which emerges here, rather nearer the upper than the lower border of the pons.

THE MEDULLA.

The medulla or bulb is rather conical in shape its upper broad end or base being next to the pons. Its lower end is continuous with the spinal cord at the foramen magnum. It measures one inch in length.

Its anterior aspect rests in the basilar groove on the occipital bone, and presents a mesial longitudinal groove on each side of which is an elongated projection, the pyramid, produced by the pyramidal motor fibres as they run downwards to the spinal cord. Ninety per cent of these fibres decussate at the lower end of the medulla to form the crossed pyramidal tracts of the spinal cord, the remainder being continued downwards as the direct pyramidal tract. This is termed the decussation of the pyramids, which, it may be noted, interrupts the lower end of the mesial longitudinal groove. External to the upper half of each pyramid is an oval eminence, half an inch long, termed the olive which contains the olivary nuclei. No fewer than seven of the cranial nerves make their appearance round this structure. For example the sixth, seventh and eighth appear between it and the pons in that order from within outwards; the ninth, tenth and eleventh nerves emerge behind it; while the numerous rootlets of the twelfth make their exit between it and the pyramid. Below the level of the olive the direct and indirect cerebellar tracts may be distinguished. The latter is next to the pyramid, and when traced upwards disappears under the olive. It is continued upwards in the substance of the medulla, and enters the cerebellum through its superior peduncle. The direct cerebellar tract inclines upwards behind the olive, and enters the cerebellum through its inferior peduncle.

DISSECTION.—Split the cerebellum by a mesial section and turn the halves aside in order to get a good view of the posterior aspect of the medulla and the floor of the fourth ventricle.

It will be observed that the posterior aspect of the medulla also possesses a mesial longitudinal groove, but this exists only in the lower half, as the upper half opens out to form the floor of the fourth ventricle. On each side of the posterior mesial longitudinal groove is a well marked tract termed the funiculus gracilis. This is the continuation of the postero-internal sensory tract of the spinal cord, and ends above in a swelling produced by the nucleus gracilis. Immediately external to each funiculus gracilis is another well defined tract termed the funiculus cuneatus. This is a continuation of the postero-external sensory tract of the spinal cord, and ends above in a swelling produced by the nucleus cuneatus. It

may be stated here that a fresh relay of sensory fibres springs from the nucleus gracilis and the nucleus cuneatus, and after decussating, is continued upwards towards the hemisphere as the mesial fillet.

Immediately external to the funiculus cuneatus is an elongated band of neuroglia tissue which comes to the surface at this point. Beyond this again is the direct cerebellar tract which has been already studied from the front. At the upper end of each lateral aspect of the medulla is the prominent inferior peduncle of the cerebellum which connects the latter with the medulla and spinal cord.

THE FOURTH VENTRICLE.

This is a diamond shaped space situated on the dorsal aspects of the pons and medulla, one half of the floor being formed by each. It also possesses lateral boundaries and a roof. The upper end of the cavity is continuous with the aqueduct while the lower end is prolonged into the central canal of the spinal cord which also tunnels the lower half of the medulla.

The floor is bisected by the mesial longitudinal groove, while it is crossed transversely about its middle by the striae acousticae, so called because they are associated with the eighth cranial nerve. In this way the floor is divided into two upper and two lower portions each of which presents a slight depression termed a fovea, of which, therefore, two are superior and two inferior. Each inferior fovea is V shaped, with the apex upwards, between the two limbs of which lie the chief nuclei of origin for the ninth, tenth and eleventh cranial nerves. Between each inferior fovea and the mesial longitudinal groove is the nucleus of origin of the twelfth cranial nerve. Immediately above the striae acousticae, and on each side of the mid line is a rounded projection termed the eminentia teres. This is produced by the nuclei of the sixth and seventh cranial nerves, of which the latter is the deeper. The superior fovea is situated above and external to this, while towards the upper angle of the floor is a tiny pigmented patch under the ependyma. In each lateral angle of the floor are situated the nuclei of origin of the eighth cranial nerve. These are in two groups, one for the cochlear and the other for the vestibular division of the nerve.

Each lateral boundary of the fourth ventricle is formed from above downward by the superior cerebellar peduncle, the inferior cerebellar peduncle, the nucleus cuneatus and the nucleus gracilis.

The roof of the fourth ventricle is formed by the following from above downwards—

(1) The superior medullary velum, which is a thin lamina occupying the upper angle of the roof. From its upper surface emerge the two trochlear nerves. This lamina passes into the cerebellum.

(2) The cerebellum itself.

(3) The inferior medullary velum which is a thin lamina emerging from the white matter of the cerebellum.

(4) The remainder of the roof is formed by the pia mater lined with ependyma, and exhibits a small choroid plexus of blood vessels projecting into the

cavity. This portion of the roof is perforated by one or more openings through which the cerebro-spinal fluid escapes into the subarachnoid space.

THE CEREBELLUM.

This consists of two lateral lobes connected in the mesial plane by the vermis, so termed from its segmented appearance. The convolutions of the cerebellum are closely packed together like the leaves of a book and are therefore termed folia. These are collected into groups by deeper fissures, and have been given more or less fanciful names, which are merely of interest as such and possess no clinical significance. They are therefore a burden on the memory. On examining the mesial section of the vermis it presents a characteristic appearance, which has been aptly termed the tree of life, from its elaborate branching arrangement.

The cerebellum possesses superior, middle and inferior peduncles. The two superior connect it with the cerebral hemispheres, the two inferior with the medulla and spinal cord, while the middle peduncle forms the superficial transverse fibres of the pons, and connects together the two lateral lobes of the cerebellum.

The white matter of each lateral lobe of the cerebellum presents a crumpled sheet of grey matter termed the corpus dentatum.

THE SPINAL CORD AND ITS MEMBRANES.

DISSECTION.—The spinal cord is extracted from the spinal canal by sawing through the laminae, and then releasing the cord and its membranes by severing the spinal nerves. The cord should be taken out after the removal of the brain.

The spinal cord is clothed by the same three meninges as the brain.

The dura mater of the cord is a loose bag which is attached above to the margins of the foramen magnum, where it is continuous with the inner or supporting layer of the dura of the brain. It extends downwards as far as the level of the second or third sacral vertebra, where it ends by blending with the filum terminale of the cord. Laterally it ends by blending with the sheaths of the spinal nerves. The mode of exit of the latter will require to be studied by slitting the dura mater longitudinally, when it will be noted that the anterior and posterior roots of each spinal nerve possesses separate openings, and unite within a funnel like extension of the dura which finally ends by blending with the sheath of the completed spinal nerve.

The arachnoid mater of the cord is very difficult to define owing to its transparency and the delicacy of its texture. It is non-vascular as in the case of the brain and extends downwards as far as the dura. It is the subarachnoid space that is opened in lumbar puncture.

The pia mater of the cord is its vascular membrane and invests it closely. It ends below by blending with the filum terminale. It dips into the anterior mesial longitudinal fissure of the cord, but this is disguised by the fact that it forms

a narrow glistening band, termed the linea splendens, which is fused to the lips of the fissure. The anterior surface of the cord is distinguished from the posterior by this band. Attached along each lateral aspect of the cord is the ligamentum denticulatum, so termed from the fact that its outer border is broken up into 20 or 22 denticulations by which it is attached to the dura mater. This arrangement is of course necessary in order to permit of the exits of the spinal nerves, between which the pointed processes of the ligament are attached to the dura mater. Posteriorly the fragile septum posticum, which connects the pia to the arachnoid, may be detected.

The origin of the spinal arteries from the vertebral arteries has been already described. The anterior spinal trunk courses downwards underneath the linea splendens, while the two posterior spinal arteries are directed downwards upon each lateral aspect. These arteries are reinforced all the way down by anastomosing twigs from the vertebral, intercostal, lumbar and lateral sacral arteries, which run inwards along the spinal nerve roots. There are six ill defined longitudinal columns of minute veins along the cord. These drain into a venous plexus external to the dura mater and this in its turn is drained into the vertebral, intercostal, lumbar and lateral sacral veins.

THE SPINAL CORD.

The spinal cord as a rule is just under eighteen inches in length, and is, of course, longer in the male than in the female. It is continuous above with the medulla at the foramen magnum, and it ends below opposite the lower border of the first or the upper border of the second lumbar vertebra by becoming continuous with the thin thread-like filum terminale. The latter is prolonged downwards to be attached to the posterior aspect of the coccyx. It will be observed that the spinal cord is not uniformly cylindrical. It presents two enlargements—cervical and lumbar. The cervical enlargement begins at the foramen magnum, is widest opposite the origin of the sixth cervical nerve and fades away below opposite the origin of the second dorsal nerve. The lumbar enlargement begins opposite the tenth dorsal vertebra, is widest opposite the twelfth, and then rapidly tapers away towards the lower end of the cord. The cervical enlargement is associated with the origins of the cervical and brachial plexus, and the lumbar enlargement with the origins of the lumbar and sacral plexuses. Owing to the spinal cord being so much shorter than the spinal canal, the spinal nerves have to travel gradually increasing distances from above downwards in order to reach their foramina of exit from the spinal canal. The result is that the roots of the lumbar and sacral nerves form an elongated cluster within the dura mater, which has been aptly termed the mare's tail.

Examine the upper end of the cord for the spinal portion of the accessory nerve which arises by rootlets from each lateral aspect as far down as the sixth cervical segment.

It should be noted that the exit of the fibres of each of the anterior or motor spinal nerve roots is spread over an irregular area, while that of the posterior or

sensory nerve roots forms almost one continuous line down the cord. The ganglia on the posterior roots should be looked for close to their points of junction with the motor roots. The result of the union of the two roots is to form the spinal nerve which has merely a momentary existence for the purpose of allowing an intermingling of the two kinds of fibres. The spinal nerve then divides into anterior and posterior divisions of which the posterior proceed backwards to supply the tissues and skin of the back by outer and inner branches usually, while the anterior divisions sweep forwards to supply the body wall or furnish the various limb plexuses to the upper and lower extremities.

Some slight idea of the structure of the cord may be gleaned in the dissecting room by means of transverse sections at different levels. Note first of all that the white matter which constitutes the superficial layer of the spinal cord gradually diminishes in amount from above downwards. The grey matter in the interior forms an H shaped mass in the centre of the cross limb of which the minute central canal of the cord may be distinguished by means of a powerful lens. The anterior and posterior horns of the grey matter are readily distinguished, as also their association with the anterior and posterior spinal nerve roots.

The white matter is divided by these into anterior, lateral and posterior columns on each side. The position of the various nerve tracts in these can of course only be demonstrated satisfactorily by means of special stains and the use of the microscope. A certain amount of information can however be gained even by a naked eye inspection. For example, each posterior column is occupied by the postero-internal and postero-external sensory tracts which are separated from their fellows by a mesial partition of neuroglia. The crossed pyramidal motor tracts can be located approximately in the posterior halves of the lateral columns, each being separated from the surface of the cord by the direct cerebellar tract, in front of which lies the indirect cerebellar tract, also on the surface of the cord. A narrow strip of territory on each side of the anterior mesial fissure of the cord is occupied by the direct pyramidal motor tract.

THE CHIEF CONDUCTING PATHS OF THE BRAIN AND CORD.

The motor fibres that take origin from the pyramidal cells of the cortical sensori-motor areas descend in the corona radiata. After giving off collaterals that cross in the corpus callosum to communicate with the grey matter in the opposite hemisphere, the motor tract traverses the internal capsule and then enters the mid brain, where it occupies the middle three-fifths of the crusta. In the pons it is found on each side of the basilar groove and is there much broken up into bundles by the pontine nuclei and the transverse system of pontine fibres In the medulla the motor fibres again reach the surface, and lie in the anterior pyramid on each side of the mesial groove. At the lower end of this the motor decussation takes place, from 75 to 90% of the fibres crossing at this level to form the crossed pyramidal tract of the opposite side. The fibres of the direct pyramidal tract decussate as they descend the spinal cord, and this crossing is completed in the dorsal region. The lower ends of these axons terminate in arborisations round the motor nerve cells in the anterior horn of the spinal cord.

The term upper neuron is applied to a pyramidal cell of the sensori-motor area together with its greatly attenuated axis cylinder. If the latter be servered a descending degeneration takes place from that point. Therefore injury of the pyramidal tract gives rise to a special form of paralysis called spastic paralysis. Note that in this case there is no muscular atrophy as the muscles are still under the influence of their trophic centres which are the motor cells in the anterior cornua of the spinal cord.

The lower neuron consists of the motor cell in the anterior horn of the spinal cord *plus* its axis cylinder which goes directly to the muscle it supplies. Section of it is followed by both muscular atrophy and muscular paralysis.

The cells in the ganglia on the sensory roots of the spinal nerves possess central and peripheral processes. The latter contain two main groups of fibres, namely, those that convey tactile and other sensations from the skin, and those associated with the muscle sense. A certain proportion of the fibres of the dorsal spinal roots pass to cells in the posterior horn and also to cells in Clarke's column. The majority of the dorsal root fibres, however, traverse the tract of Lissauer the postero-external tract (Burdach) and the postero-internal tract (Goll). Their terminal arborisations are around cells in the nucleus cuneatus and the nucleus gracilis. From the latter nuclei a fresh relay of fibres is derived, forming the mesial fillet. This decussates in the upper part of the medulla and terminates in the optic thalamus. Fresh axons from cells in the latter continue the afferent path upwards through the posterior part of the internal capsule to the sensori-motor areas of the hemisphere.

The cells of the posterior horn of the cord give rise to two groups of fibres which cross to the opposite side in the anterior white commissure. They are directed upwards in the anterior and lateral columns of the cord as the spinal fillet (lemniscus) which joins the lateral fillet or lemniscus in the hind brain. They transmit the sensations of pain, heat, cold, touch and pressure.

The lateral fillet is composed of fibres from the nuclei of the cochlear division of the auditory nerve, together with others from the superior olive and the trapezoid nuclei. Some of these fibres are uncrossed, but the majority decussate. The lateral fillet is also joined by the spinal fillet. A proportion of these combined fibres proceeds to the inferior corpus quadrigeminum of the same or opposite side, whilst others are continued on to the thalamus and thence through the posterior part of the internal capsule to the auditory centre in the temporal lobe or the somaesthetic areas in the ascending parietal convolution as the case may be.

The direct cerebellar tract takes origin from the group of cells in the grey matter of the cord called Clarke's column. This group exists only in the dorsal region. The axons from these cells that form this tract are directed upwards, and, as already shown, enter the cerebellum through its inferior peduncle. They end in arborisations around the antler cells of the cerebellum. Note that the constituent fibres of this tract do not decussate.

The indirect cerebellar tract on the other hand is a decussation tract. After taking origin from cells in the grey matter of the cord, the axons cross to the

opposite side and enter the cerebellum through its superior peduncle. They end in arborisations around the antler cells of the cerebellum. Note that both these cerebellar tracts are ascending.

LESS WELL DEFINED TRACTS OF THE SPINAL CORD.

There are other tracts in the cord, the positions of which are more difficult to determine.

The vestibulo-spinal tract is situated in the anterior column of the cord. Its fibres arise from the chief vestibular nucleus (Deiters) of the auditory nerve, hence its name. It is therefore a descending tract, and its fibres presumably terminate in arborisations around the nerve cells of the cord.

The tecto-spinal tract is also found in the anterior column of the cord, but some of its fibres are intermingled with those of the rubro-spinal tract in the lateral column. It arises from the nuclei in the corpora quadrigemina and its fibres terminate around certain of the nerve cells of the cord. It is a descending tract.

The rubro-spinal tract is found in the lateral column of the cord, immediately anterior to the crossed pyramidal tract. Its fibres take origin from the red nucleus in the mid brain , cross to the opposite side and terminate in arborisations around the motor calls of the anterior horn of the cord. It is therefore a descending tract. Some of its fibres have relay stations in the hind brain.

The olivo-spinal tract (Helweg) is very small. It lies in the lateral column of the cord next to the surface and close to the emerging motor roots. From its name it is supposed to take origin from the inferior olivary nucleus of the medulla, but its exact connections are very indefinite. It probably contains both ascending and descending fibres.

The tract of Lissauer is situated in the lateral column of the cord close to the entering sensory roots, some of which run upwards in it for a short distance and thus create its existence. A certain proportion of its fibres are intersegmental.

The septo-marginal tract lies between the mesial septum and the postero-internal tract while the comma tract is placed between the latter and the postero-external tract. These two minute tracts are shown best in the cervical and upper dorsal regions. Their constituent fibres are intersegmental. Some are therefore ascending and others descending.

DESCENDING TRACTS OF THE CORD.	ASCENDING TRACTS OF THE CORD.
Crossed Pyramidal	Direct Cerebellar
Direct Pyramidal	Indirect Cerebellar
Rubro-spinal	Postero-external (Burdach)
Vestibulo-spinal	Postero-internal (Goll)
Tecto-spinal	Tract of Lissauer
Olivo-spinal (ascending and descending)	The Spinal Fillets
Comma and Septo-marginal (ascending and descending)	

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Knowledge Returns

	?			TOTAL
[illegible]	1+,	2-,	3,	4+, = 10
[illegible]	1-,	2-,	3-,	4+, = 9
[illegible]	1+,	2+,	3+,	4+, = 12
[illegible]	1+,	2+,	3+,	4+, = 12
[illegible]	1+,	2+,	3+,	4+, = 12
[illegible]	1+,	2+,	3+,	4, = 11.5
[illegible]	1-,	2,	3-,	4+, = 9
[illegible]	1,	2,	3+,	4+, = 11
[illegible]	1+,	2,	3+,	4+, = 11.5
[illegible]	1+,	2+,	3+,	4, = 11.5